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and Maintenance of Way

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New Standard Cross Tie

THE standard practice in roadbed construction is similar to that of the Illinois Central Railroad, outlined elsewhere in this issue. Changes, however, referring particularly to the size of tie, are being agitated by roadmasters because they believe a cross-tie of increased bearing area will reduce the cost of maintenance of roadbed.

The present standard tie is a 6x8-in. by 8-ft. This tie has been used by the railroads for the past quarter century and is said to have given the most satisfactory service until the heavier rolling stock was placed on the roads. On account of the present weight, speed and frequency of traffic, it is recommended that a 7x9-in. by 9-ft. tie be used.

The bearing surface is 26.5 percent greater for the larger tie and for this reason it is claimed that the number of roadbed renewals would be reduced. The shocks, caused by the thrust of the drivers, are distributed, not effecting the ballast to such a great extent. The object is to obtain a tie of greater bearing area, but the depth of the tie is also increased to give it greater strength. The stress in the tie would be increased slightly if the same section were used, but due to the enlarged section the stresses are lower.

The smaller size of tie is advocated on account of the scarcity of timber. It is thought that in future years the supply will be even less and the demand will be greater. On account of the age of the timber which will furnish the 6x8-in. tie, a greater number of them will be obtainable.

The life of the heavier tie is longer, however, because respiking of the tie is less frequent on account of the fewer roadbed renewals. Respiking often renders a tie useless before disintegration occurs. Deterioration, due to the atmosphere, is about the same for all sizes of ties and therefore the life of the tie is not based thereon.

In conclusion it might be said that the increase in cost of timber for supplying the 7x9-in. by 9-ft. tie is more than balanced by the longer life of the tie and the decreased cost of maintenance of roadbed. In consideration of these points, it appears that the heavier tie would be the more economical and should therefore be adopted as a new standard for the lines with the heavier rolling stock of the present day.

Design of Railway Bridges

THE general principles, governing the theory of bridge design, have been known for a long time. The specifications for loading and for the unit stresses are very explicit. The calculation of stresses in chords, due to dead loads, live loads, etc., is very well understood. The stresses in the parts, which go to make up these members cannot, however, be calculated and must be assumed.

The falling of the Quebec bridge emphasizes this latter statement. The cause of the failure is generally thought to have been due to a failure of one of the

compression members. This chord was designed similar to all other compression members and, as far as unit stresses are concerned, these stresses were well below the elastic limit. The cause of the failure of this chord can only be surmised. It is very probable that the component parts did not act as a single member, thereby causing certain sections of the chord to be strained beyond the elastic limit. If this is really the cause, one cannot say with any assurance that large compression members made up of many parts, will act as a single unit in resisting loads.

In order to overcome the difficulty a factor of safety is usually given. This factor does not secure results, however, in the case of these large compression members because the factor of safety is given for the unit stresses in the member itself and does not effect the bracing and rivets of the chord.

A thorough understanding of the stresses in the bracing of chords can only be had by tests. The cost of this experimental data will be so high that it will probably have to be undertaken by the government. While government tests in all other lines have been very extensive, up to the present time it was not deemed necessary to make these tests on large compression members of railway bridges. The necessity has only recently been shown by the great disaster, the falling of the Quebec bridge.

The Engineering Convention

THE chief aim of the engineering convention is to secure standardization of design and construction. Engineers of experience are brought together from all sections of the country, whose knowledge covers the best practice in all matters. One must agree that in no other way can improved methods and design be secured.

The progress reports of the committees are supplemented by the discussions of the society members. Facts are brought out from the experience of one man which would otherwise have remained unknown to the engineering profession. The discussions at these conventions become heart to heart talks between the members. Each man carries away with him information which will be of intense practical value in the pursuit of his work.

Changes in old standards are often advocated on account of new experiences of the engineers. Engineering is a profession in which better and more economical designs are continually being brought out.

A feature of the convention, which is not generally thought of but which is really of great importance, is the association of the men engaged in the same class of work. The acquaintanceship, which is here formed, encourages intercommunication, allowing one man to make a request of another for certain information which he does not happen to have on hand.

An opportunity is also offered the society members of serving on committees. The chief advantage of this lies in the thorough investigation which they are called upon to make. It is an advantage because they must make a careful study of facts, thereby acquainting themselves sometimes with a new subject and adding to their store of knowledge. The appointment to a committee carries with it the privilege of inquiring into the experience of other members. It is a chance which should not be neglected, because in this age one cannot gain too much knowledge. It broadens the view of the engineer to grapple with new problems in his profession.

The value of the exhibits lies in the demonstration of the operation of new equipment. There is also an advantage of having the manufacturer explain the apparatus thoroughly. It is often the case that an engineer will learn from these exhibits that which will convince him of the efficiency of the apparatus. Every one will agree that the exhibition of its operation is the most convincing argument in favor of its adoption.

While many good results are secured from a convention, the most important one is the standardization which is done. The convention offers the best opportunity for this particular work, being an assemblage of the most interested persons.

Rail Question

IDEAL conditions have not as yet been attained in the design and manufacture of steel rails. There is continued controversy in regard to the section of rail and the method of manufacture. Almost every road has decided upon the weight of rail which should be suited to its traffic.

Present practice in regard to the weight of rail varies for the different roads throughout the country. In some cases a light rail will suffice for the weight of rolling stock, while in other cases the heavier rail from 85 to 100 pounds is essential. The tendency, however, is to increase the weight of rail, whether or not the weight of rolling stock actually demands it. There are several reasons for this, which are based primarily on cost of maintenance. With heavier rails, a smaller number of ties is necessary and repairs to the roadbed are reduced. Then again, the cost of a heavier rail is increased in a smaller ratio than the strength and stiffness of the rail. For this reason, it is thought that it will prove economical to increase the weight of rail to some extent.

Previous to the adoption of the standard A. S. C. E. rail section, there was a variety of designs. The results of experience were introduced into this A. S. C. E. design and it was thought at the time that the section would prove an ideal one. The chief trouble has come about through the proportions of metal which were allowed for the head, web and flange of the rail. In this standard design the proportions are 42 per cent for the head, 21 per cent for the web and 37 per cent for the flange. With this proportioning, it has been discovered that intense cooling strains are developed in the process of rolling the rail. Other designs have been suggested occasionally in which the proportion of metal in the flange and head are

the reverse of the A. S. C. E. section. Up to the present time, however, no definite action has been taken by the railroads in general as to a change of rail sections. In the near future, it is expected that the American Society of Civil Engineers will present a new design of rail section, as the matter is now in the hands of a committee.

The method of manufacture of steel rails has been specified by several engineering societies. The solidification of the ingots is a point to which particular attention has been given. It is required that the ingots should be allowed to cool sufficiently for the interior to become solid. In order to overcome piping, it has recently been decided that 25 per cent of the metal must be sheared off from the end of blooms which are formed from the top of the ingot. The specification for the chemical composition of the steel allows for a percentage of carbon varying between 0.50 and 0.65 per cent., increasing from a lower to a higher value with the weight of rail. The percentages of phosphorus, silicon and sulphur are limited to 0.085, 0.20 and 0.075 per cent. respectively. The proportion of manganese, which is allowed, varies between 0.75 and 1.05 per cent. These proportions refer to steel rails manufactured by the Bessemer process. A slight variation from above chemical composition is specified for rails manufactured by the basic open hearth process.

It is hoped that ideal conditions will be attained by the new specifications which are under consideration. The defects of the present design are very well understood and therefore the engineers will be able to cope with known difficulties.

Track Circuits for Illuminated Track Indicators

New York Central and Hudson River Railroad

A DIFFICULTY, which is sometimes met with in locating interlocking towers, is to obtain a clear view of the tracks. There are often-time many obstructions, such as other buildings, bridges and their supports, etc., which limit the view of the signalman, and thus make the operation of the interlocking unsatisfactory. The illuminated track indicator is a solution of this problem.

The diagram shows the locking circuits for High Bridge, New York, Tower "D," being the same plant in which the illuminated track indicator, here illustrated, is installed.

The relays, marked B, U, V, etc., are small polyphase induction motors. One phase of these motors is operated from the track and the other from the line. The motors and also the track transformers are usually placed in iron track boxes at the side of the track.

The relays, marked AR, BR, FR, etc., are located in a relay cupboard in the lower story of the tower. They are operated either by the polyphase motor relays or by secondary track relays, shown at F and A, which are themselves actuated by the motors. These relays, F and A, are located in relay boxes placed on the signal bridge.

The relays, AR, BR, FR, etc., mentioned above, control the lighting circuit of the illuminated track indicator, which is located above the interlocking machine in the upper story of the tower. These relays also control the locks for switches and signals, which are placed on the levers of the machine. These locks are operated by means of low voltage storage batteries, located in the battery house together with the 110-volt interlocking batteries. This is the only apparatus, with the exception of the interlocking machine proper, for which direct current is used.

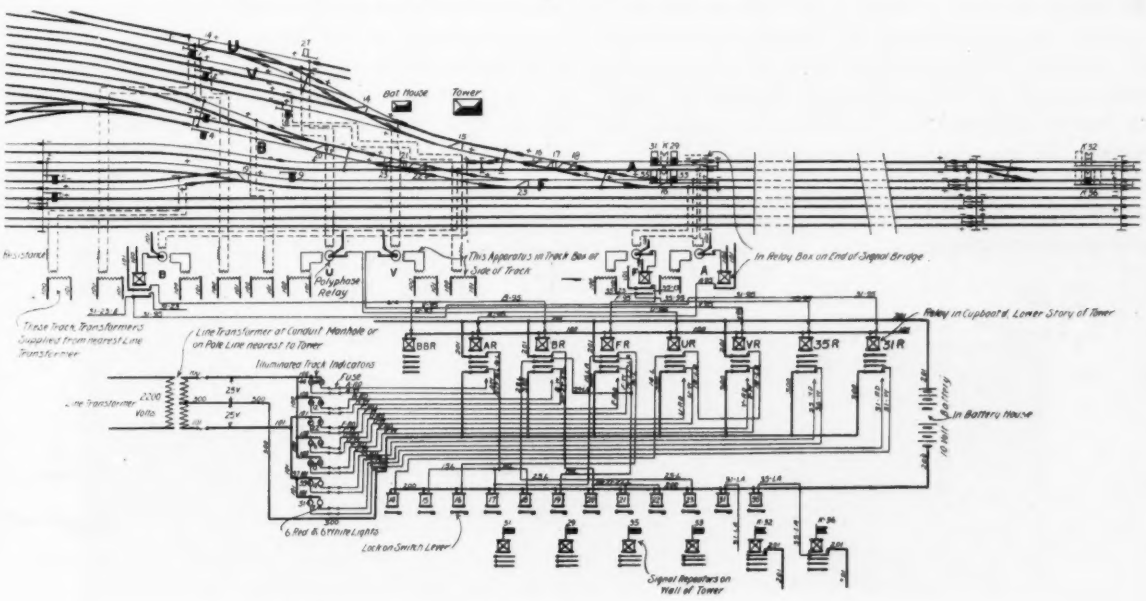
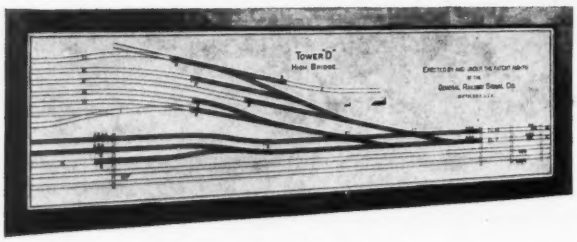

Boat House
Tower
Polyphase Relay
In This Apparatus in Track Box at Side of Track
In Relay Box on End of Signal Bridge
Relays in Cupboard, Lower Story of Tower
These Track Transformers Supplied from nearest Line Transformer
Line Transformer at Conduit Manhole or on Pole Line nearest to Tower
Illuminated Track Indicators
Line Transformer 2200 Volts
25 V
In Battery House
6 Red & 6 White Lights
Lock on Switch Lever
Signal Repeaters on Wall of Tower

DIAGRAM OF LOCKING CIRCUITS, HIGH BRIDGE, TOWER D, N. Y. C. & H. R. R. R.

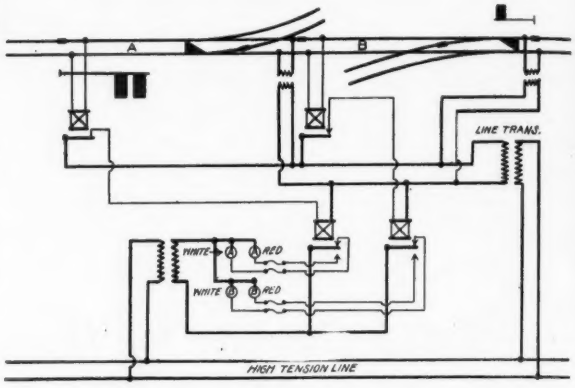


ILLUMINATED TRACK INDICATOR

In the wiring diagram for the illuminated indicator, shown below the track circuits, the figures between the red and white lights indicate the number of lamps in that particular section. Referring to track section "A" on the indicator, the circuit plan indicates only one red and one white light, the number 14 indicating the actual number of lamps which are placed 2 inches on center and wired in multiple. The number of lamps are determined by the length of the section, and consist of one-half red and one-half white lights.

A line transformer, having a voltage ratio of 2200 to 50-25, supplies the alternating current. The transformer may be located at a conduit manhole or on a pole line, depending upon whether distribution is by conduit system or aerial line. The nearest line transformer to the tower is used for supplying the current. As is shown there are 50 volts between secondary terminals, 100 and 101, and 25 volts between the middle tap and terminals.

When a track section is not occupied by a train, the current passes from one terminal of the line transformer through the track to one coil of the polyphase relay and back through the track to the transformer. The second coil of the relay is fed directly from the transformers. If a train occupies the track section the current is shunted from one phase of the relay.



TYPICAL CIRCUIT FOR ILLUMINATED TRACK INDICATOR

When a red light is shown on the indicator, the lock on the switch lever has also been closed, thereby preventing the operation of a switch under a moving train. The operation of the various relays may be easily understood by an inspection of the diagram of circuits.

The illuminated track indicator is a thin box with a glass cover, upon which is painted a plan of the tracks and the various signals. The numbers on the indicator correspond to the numbers of the levers, operating the same section of track.

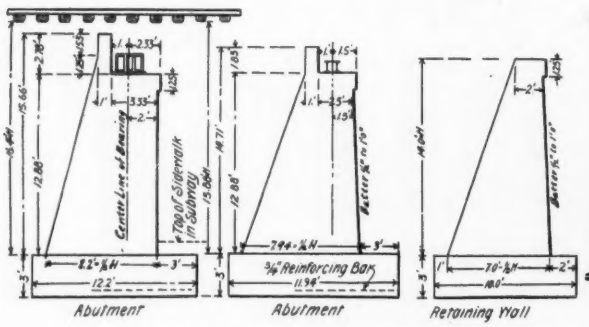
Track Elevation Details

C. & W. I. R. R.

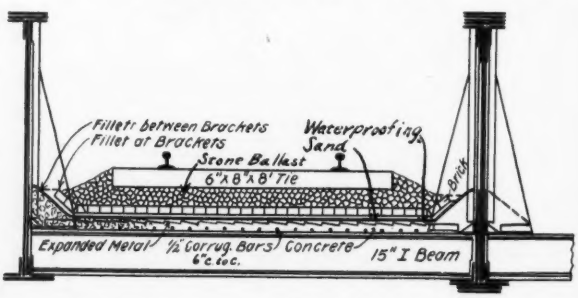
TRACK elevation work has been in progress for the past several years in the city of Chicago and vicinity. Both the structures and the methods of construction have assumed a standard form during this time. A few details of construction, used by the Chicago and Western Indiana Railroad, E. H. Lee, chief engineer, are shown in the accompanying illustrations.

Typical abutments and retaining wall are shown in cross-section. The abutments are of two different sections, one being used for grade crossings of deck girder type and the other for crossings of the through girder type. The width of the abutment at the top of footing is made one-half the distance from footing to bottom of tie. The width of the retaining wall at the top surface of footing is one-half the distance from footing to top of wall.

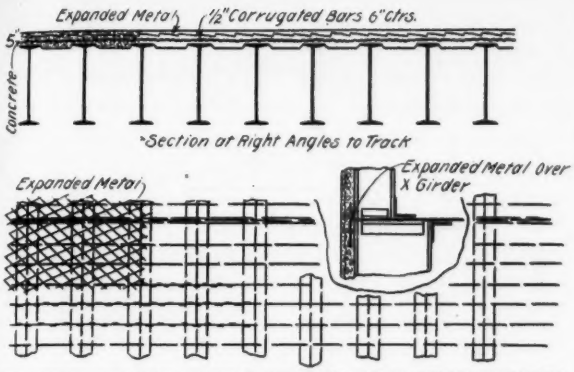
The reinforced concrete bridge floor with brick covering for the through girder type of grade crossing is



TRACK ELEVATION DETAILS



REINFORCED CONCRETE BRIDGE FLOOR, THROUGH GIRDER, TRACK ELEVATION DETAIL

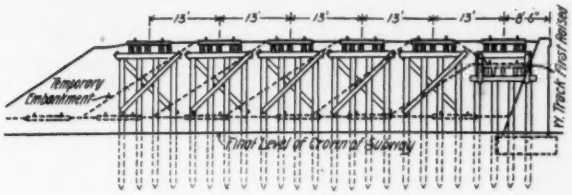


REINFORCED CONCRETE BRIDGE FLOOR. DECK GIRDER, TRACK ELEVATION DETAILS

shown in cross-section. The concrete is 5 inches in depth, being reinforced with ½-inch corrugated bars, spaced 6 inches on centers, and also expanded metal, placed 1 inch from upper surface of concrete. Waterproofing is laid on the concrete and is covered with a layer of sand upon which 2¼-inch brick is laid. Six inches of stone ballast is placed on the brick to support the 6x8-inch by 8-foot ties.

The reinforced concrete bridge floor for the deck girder type of grade crossing is shown in plan and section. The concrete is 5 inches in depth and is reinforced with ½-inch corrugated bars, placed 6 inches on centers, and expanded metal. The bars are placed 3¾ inches below top surface of concrete and the expanded metal, 1 inch below top surface.

A typical cross-section of subway is also given, which shows the method of elevating tracks. The first raise of



METHOD OF ELEVATING TRACKS, TRACK ELEVATION DETAILS

the west track was about ½ the full elevation. The second track from the west side was then raised to its full elevation. After this was completed, the first track on the west side was raised to its final elevation. The succeeding tracks were given the final elevation on the first raise.

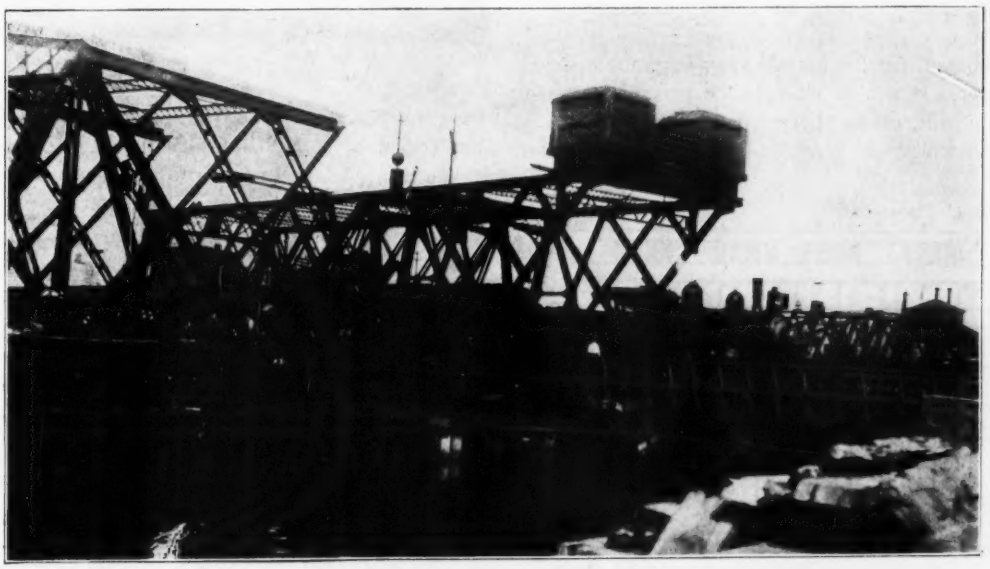
A Temporary Trestle

C. & N. W. Ry.

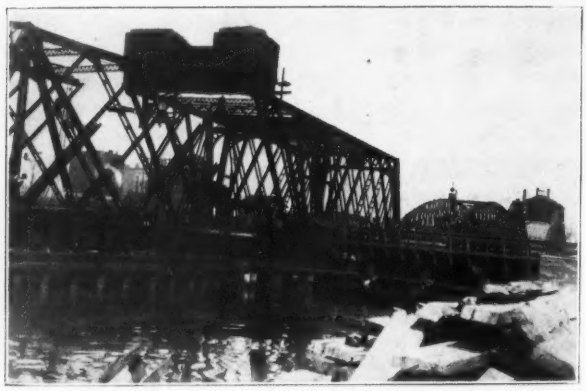
ON the Chicago and Northwestern road, the old center-pier bridge at Kinzie Street, Chicago, is to be replaced by a Strauss trunnion, bascule, single leaf bridge. In order to construct this new bridge, it was necessary to remove one arm of the center-pier bridge, which would swing over the abutment of the bascule, the center line of the bascule being only 50 feet south of the center line of the swing bridge.

The bridge is located immediately beyond the Wells Street station of the road. For this reason there were no terminal facilities at this point as long as the bridge remained in the open position. The temporary trestle had to be erected with great speed. The task was accomplished between the hours of 9:40 a. m. and 5:30 p. m., during which time traffic was suspended.

The bridge was swung into the open position and a section of the south arm was severed with hack saws and air drills. This section of the bridge was blocked up



KINZIE STREET BRIDGE IN CLOSED POSITION, SHOWING TEMPORARY TRESTLE



KINZIE STREET BRIDGE IN OPEN POSITION

on the south protection pier, being dragged about a foot to the south. The weight of the unshortened end had to be counterbalanced and, therefore, 165 tons of pig iron were hoisted into securely bolted wooden boxes resting on transverse struts of I-beams which were placed at the extreme ends of the top chords. This work was accomplished with a large floating derrick by the Great Lakes Dredge and Dock Company.

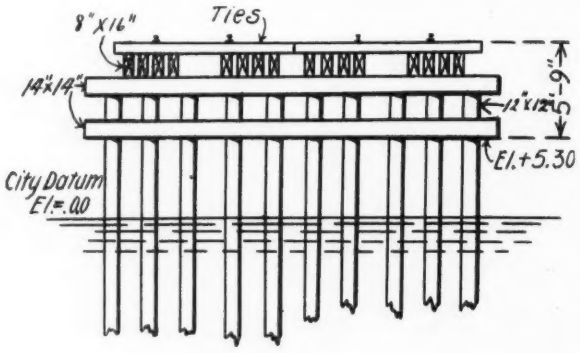
By means of the derrick, caps and stringers were placed for the temporary bridge on the piling which had already been driven. The timber had been cut and could be spiked in place by gangs of laborers, working from scows in the river.

The trestle is about 73 feet in length and 28 feet in width, carrying two tracks from the shore line to the remaining section of the center-pier structure. It is constructed as shown in the sectional plan and the illustrations. There is a flooring across the ties between the rails and a railing on each side.

The present arrangement gives a clear channel of 56 feet on the west side of the river as before. When the bascule bridge is completed, there will be a clear channel of 100 feet.

The abutment for the bascule span is on the east side of the river. It will be built by the pneumatic caisson process and will rest on piles 18 feet below Chicago City datum. The pier will reach bed rock, which is 95 feet below Chicago city datum. The abutment will be constructed of plain concrete.

The plans were prepared under the direction of E. C. Carter, chief engineer. The work was in charge of W. H. Finley, assistant chief engineer, assisted by I. F. Stern, bridge engineer.



SECTION OF TEMPORARY TRESTLE, KINZIE STREET BRIDGE

Inspection Car, Southern Railway

THE motor car, here shown, is in use on the St. Louis division of the Southern Railway. It was purchased from the Fairbanks-Morse Company three years ago and has given good service. It was, however, recently rebuilt in the railway company's shops, the car now having a two-cylinder water-cooled Buick engine of the 1906 type.

The car can attain a speed of 50 miles per hour. It has made several long trips, 150 miles being the longest continuous trip. The car handles very nicely and will start from rest and attain a high rate of speed in a few rail lengths. It can be stopped from a speed of 45 miles per hour within a distance of 150 feet. The weight of the car is about one ton. It is never operated on the main line except by a "31" train order.

INSPECTION CAR, SOUTHERN RAILWAY

We are indebted to C. C. Coffee, superintendent, for the above data and accompanying illustration.

The Engineering Experiment Station of the University of Illinois has just published bulletin No. 13, "An Extension of the Dewey Decimal Classification applied to Architecture and Building." This greatly extended classification has been in use in a more comprehensive form in the department of Architecture for many years, but it has never before been published. It forms a supplement to the extended classification applied to the branches of engineering previously issued in Bulletin No. 9.

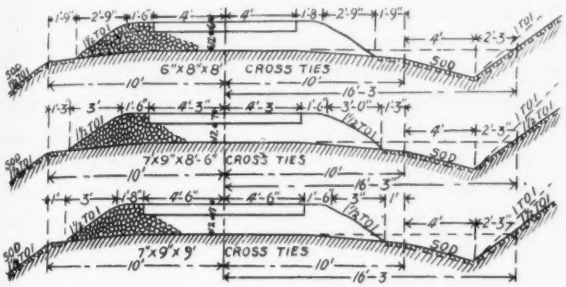
Copies may be secured upon application to the Director of the Engineering Experiment Station, Urbana, Illinois.

Standard Roadbed Cross-Sections

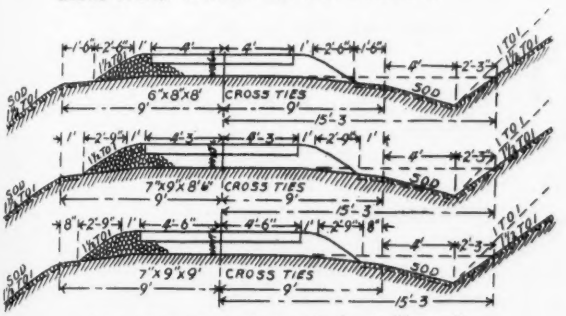
Illinois Central Railroad

THE standard roadbed cross-sections, which have been adopted by the Illinois Central Railroad, are shown below. These sections represent the present practice in roadbed construction on this road.

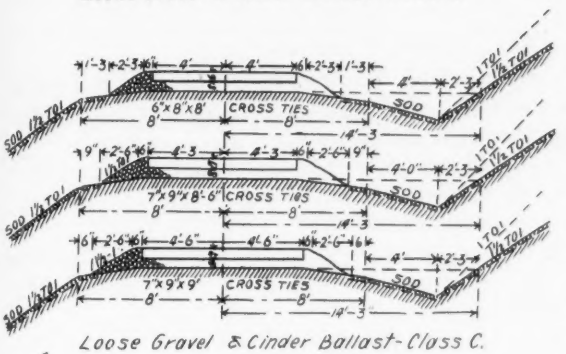
The use of one of the several classes of roadbed, A, B, or C, depends upon the importance of the section of line with regard to speed, weight and frequency of traffic. The sections of class A are used on the important main lines, the through lines for passenger and heavy freight service. Those of class B are used on main lines also, but lines which are of lesser importance. Class C sections are used only on branch lines of the road.



Loose Gravel & Cinder Ballast - Class A.



Loose Gravel & Cinder Ballast-Class B.

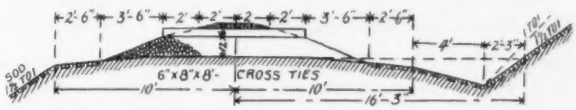


Loose Gravel & Cinder Ballast-Class C.

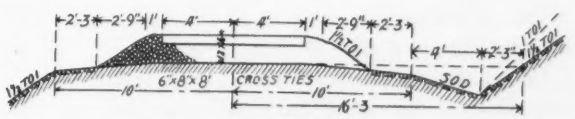
STANDARD ROADBED CROSS-SECTIONS

The variation in the different classes is in the width of roadbed and depth of ballast. Class A section has a 20-foot width of roadbed, class B has an 18-foot and class C has a 16-foot. There is a depth of ballast of 12 inches for class A, 10 inches for class B, and 8 inches for class C.

Different sizes of ties are used on several sections of the road. The standard tie for new lines is the 6x8-inch by 8-foot. The 7x9-inch by 8½-foot tie is used on a section of line upon which the tie was already laid at the time of purchase by the I. C. R. R. The 7x9-inch by 9-foot tie is a cypress cross-tie which is used in the states of Louisiana and Mississippi, the southern extremity of the road.



Cementing Gravel Ballast - Class A

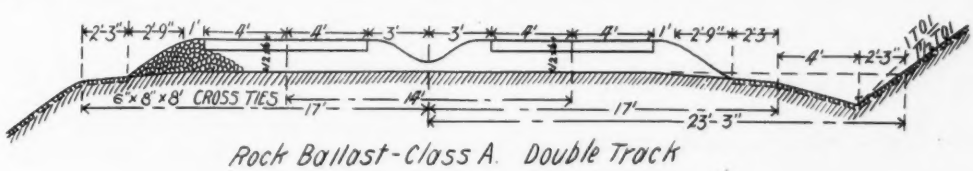


Rock Ballast - Class A

STANDARD ROADBED CROSS-SECTIONS

The ballast, to be used, depends on the location of the section of the road with respect to the source of supply. Rock ballast, cementing gravel ballast and loose gravel and cinder ballast are the kinds which are used, depending upon the importance of the line. The cementing gravel ballast is a mixture of gravel and clay, which gives a compact roadbed.

The illustrations show the various sections for all classes of loose gravel and cinder ballast, one section of class A for rock ballast and cementing gravel ballast, and one section for class A double track roadbed section. All double track sections are of class A, which has a 34-foot roadbed with 12 inches of either rock or loose gravel and cinder ballast below the tie. Only one section is shown for rock ballast and cementing gravel ballast, because the variation in detail corresponds to the sections for the loose gravel and cinder ballast.



Rock Ballast-Class A. Double Track

STANDARD ROADBED CROSS-SECTIONS

New Design of Rail Section

THERE is a feeling among many engineers that the ideal section of rail is not had in the standard A. S. C. E. section. It is thought that metal should be taken from the head and put into the flange in order to reduce the cooling strains, which are set up in the process of rolling on account of the unequal rate of cooling in the two parts.

The section, which is here shown, is a recent design by Captain Robert W. Hunt. More metal has been used in the flange than in the head. In fact, the proportions of metal in head and flange are nearly the reverse of those in the A. S. C. E. section, while the metal in the web is increased.

The width of rail is less, but the height is greater than in the A. S. M. E. section; the height of web and thickness of flange being increased and height of head being decreased. The center of gravity of the rail is lowered, the moment being increased.

In the August, 1907, issue of this paper, the results of experiments on a wide-base rail by the Atchison, Topeka & Santa Fe Railway were given. It would be well to take these tests into consideration in the discussion of this new design which is of the narrow base type.

The University of Illinois

The following news item is a communication from President James of the University of Illinois:

During the middle ages when European universities took their rise, the coming of a great professor to a state was considered one of the important events in the life of the community. When the University of Leyden was founded by the Dutch States General as a reward to the citizens of Leyden for withstanding the long siege of the Spaniards, thus saving Holland from subjugation, invitations were extended to the most eminent professors in the universities of other countries to accept chairs in the new institution. Delegations were sent by the government to persuade the men who had received these calls to accept them. When they responded to the calls they were received with open arms not merely by the university circle, but by the citizens—men, women, children, old and young, rich and poor, of Leyden and Holland. Their coming was greeted with bonfires, illuminations and celebrations such as we give to great and important events.

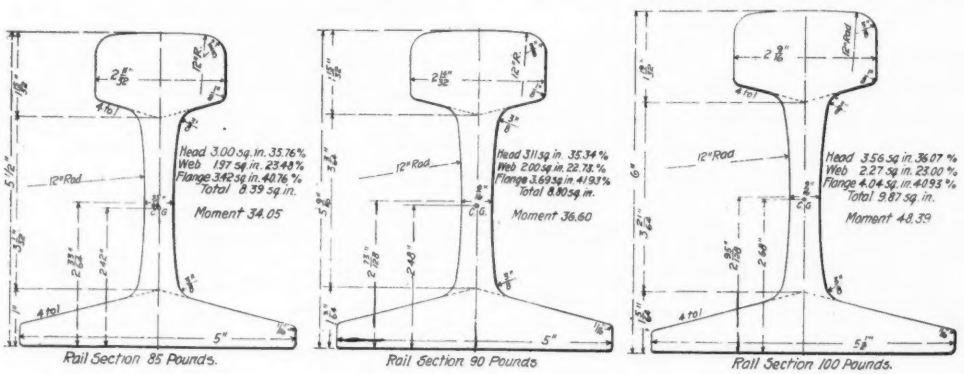
Those days have passed away never to return, but the significance of the coming of a great man into a community has not become less but much greater as the years have rolled on. The modern university is a much more comprehensive institution than the medieval. It reaches more sides of the community life and is more vital to its welfare, and the addition of each great scholar to its force is therefore more important. Prof. Goss's coming to the University of Illinois marks a new epoch in the development of engineering study in every branch of that work at our state university. In combination with the men who have organized and are conducting this work at present, we shall have, I believe, one of the strongest groups of engineering professors to be found in any institution in the world. I am sure that you, as a friend of the University, will be pleased to know these facts.

Railway Signal Association

THE annual meeting of The Railway Signal Association will be held October 8, 9 and 10 at the Public Service Building, Milwaukee, Wis.

The committee reports will cover the following subjects:

1. Automatic Block Signal Systems.
2. Maintenance of Automatic Block Signals.
3. Circuits for Interlocked Signals.
4. Storage Battery.
5. Standard Specifications for Automatic Block Signaling.
6. Costs in Estimates for Installation.
8. Standard Specifications for Electric Interlocking.
9. Signal Definitions.
10. Office Records.
11. Signal Lamps—Design, etc.
12. Rubber Covered Wire.
13. Maintenance Manual Controlled Signals.
14. Foreign Current on Automatic Block Signaling.
15. Standard Specifications for Mechanical Interlocking.
16. Circuits for Manual Block Signal Systems.


Head 3.00 sq. in. 35.76%
Web 1.97 sq. in. 23.48%
Flange 3.42 sq. in. 40.76 %
Total 8.39 sq. in.
Moment 34.05
12" Rad.
Rail Section 85 Pounds.
Head 3.11 sq. in. 35.34 %
Web 2.00 sq. in. 22.72 %
Flange 3.69 sq. in. 41.93 %
Total 8.80 sq. in.
Moment 36.60
12" Rad.
Rail Section 90 Pounds.
Head 3.56 sq. in. 36.07 %
Web 2.27 sq. in. 23.00 %
Flange 4.04 sq. in. 40.93 %
Total 9.87 sq. in.
Moment 48.39
12" Rad.
Rail Section 100 Pounds.

NEW DESIGN OF RAIL SECTION

Tie Plates and Wooden Foot Guards

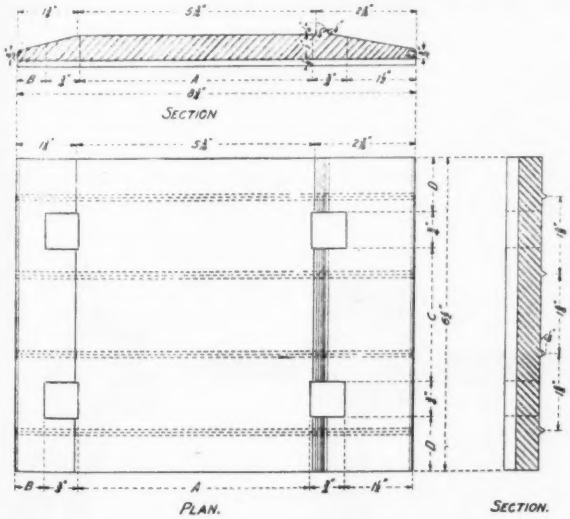
Chicago, Rock Island & Pacific Ry.

TIE plates give additional life to the ties, particularly those of the softer woods. They are used as a preventative for rail-cutting and spike-killing, which are serious troubles in maintaining the track. On curves they are used to advantage against the overturning of the rail due to lateral pressure on the head, which in turn causes rail-cutting at the outer base of rail. It is estimated that tie plates add four or five years to the life of soft wood ties and at least one or two years to the life of hard wood ties.

In the accompanying illustration, a standard tie plate of the Chicago, Rock Island & Pacific Ry. is shown. This plate was recently designed by the engineering department, J. B. Berry, chief engineer. The flanges on this plate are only ⅛ inch in depth, being much shorter than the older design. The plate is punched for four spikes.

The shorter depth of flange should give sufficient resistance between the plate and tie. It can be set much easier than the plate with deep flanges, which required a heavy sledge to set firmly. If the plate was not set firmly, it was of little value, giving excessive play to the plate and the spikes.

The tie-plate, here shown, is of style "A," which is used for rails weighing over 70 pounds per yard. Style "B" is similar in design and is used for rails weighing 70 pounds or less per yard. Style B is 8¼ inches long and has a shoulder 3-16 inch in height. The thickness of both plates is ½ inch, which to some extent compensates for the short flanges. The positions of the spike holes varies with the width of rail base, as shown in the table.



VALUES OF C & D				
RAIL SECTION	ANGLE BAR		C	D
85 & A.S.C.E.	85048	26	2¼	1⅛
80 "	80048	26	1¾	1⅞
" Revised	80048	26	1¾	1⅞
75 A.S.C.E.	75048	26	1¾	1⅞

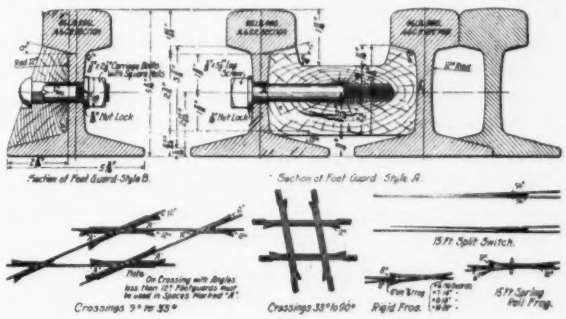
TABLE OF VARYING DIMENSIONS FOR STYLE A PLATE:					
	RAIL SECTION:				
	85 LB. A.S.C.E.	80 LB. A.S.C.E.	76 LB. FRISCO	75 LB. A.S.C.E.	100 LB. ROYDEN (also 100 LB. FRISCO)
A =	5⅛"	4⅞"	4¼"	4⅛"	4⅛"
B =	⅝	⅝	1¼"	1⅛"	1⅛"
C =	Must correspond with staggering of spike holes in the angle bars				
D =	1(1.06-(C+⅛"))				
	All other dimensions to remain as shown on drawing.				

STANDARD TIE PLATE, C., R. I. & P. RY.

The standard footguards are made of straight grained, well-seasoned oak or hard wood. These foot guards are cut to length, shaped to fit the rail section and bored for bolts before they are furnished to the track foreman.

Where foot guards are used they must be placed in frogs, crossings, guard rails, at heel of switches and all other points in the track, if the clear space between rail heads is more than three inches or less than five inches.

Two styles of foot guards are shown in the illustration.


Section of Foot Guard Style B.
Section of Foot Guard Style A.
15 Ft. Split Switch.
Crossings 9° to 33°
Crossings 33° to 90°
Rigid Frog.
15 Ft. Spring Rail Frog.

STANDARD FOOT GUARDS, C., R. I. & P. RY.

Style A foot guards are used where the web of one rail, to which the guard is to be applied, is inaccessible on one side. Style B footguards are used where the web of rail is accessible on both sides. It will be noted that a ⅝x5½ inch lag screw is used with Style A, while a ⅝x2⅞ inch carriage bolt is used with Style B. The foot guards are made both right and left-handed to suit conditions. The bottom of guards are notched by the track men to fit over the track spikes.

The application of the two styles of foot guards is shown in the drawings. For the 15-foot switch, the guard is 58 inches long and for the 24-foot, 90 inches long. Where necessary they are made of two pieces of style B for the split switch.

Association of Railway Superintendents of Bridges and Railways

THE seventeenth annual convention of the Association of Railway Superintendents of Bridges and Buildings will be held October 15, 16 and 17 at the Republican House, Milwaukee, Wis. All railway officials who are interested in the work of the association are invited to attend.

The subjects for report and discussion are as follows:

1. Experience in Concrete Bridges, Arches and Subways.
2. Concrete Building Construction.
3. Experience as to Expansion and Contraction of

Concrete Walls, either Reinforced or Plain Concrete.

4. Action of Sea Water on Concrete.

(a) Concrete made in Air and Sunk into Sea Water.

(b) Concrete Deposited Direct into Sea Water.

5. Recent Experience in the Use of Wooden and Asbestos Smoke Jacks for Engine Houses.

6. Combination Fastening and Lock for Rolling and Sliding Doors.

7. Construction of Towers and Guides for Lights on Draw Bridges.

8. Recent Experience in Protecting Steel Railroad Bridges Against the Action of Salt Brine from Refrigerator Cars.

The standing subjects, upon which committees will report, are as follows:

1. Pile and Frame Trestle Bridges.
2. Water Supply.
3. Fire Protection.
4. Fences, Road Crossings and Cattle Guards.
5. Preservatives for Wood and Metal.

The committee on entertainment will distribute a program at the convention, giving detailed information as to the side trips which are to be made. Several very interesting trips have been planned.

The program includes a morning and afternoon session on Tuesday, October 15, and Wednesday, October 16, and a morning session only on Thursday, October 17.

New Top-Mast Motor Signal

A NEW two-position top-mast electric motor signal has been brought out by the General Electric Company after a long and complete test under severe weather conditions. In outward appearance this signal is similar to the Company's three-position signal. Several new and interesting mechanical and electrical features are apparent in the signal shown in Figures 1 and 2.

The signal mechanism complete is shown in Figure 3 in the position of "proceed" as indicated by the blade. The bearings for the signal shafts and the gearing are concealed in the supporting frame which with the large door at the back forms a weather-proof case. A socket is located at the bottom of the case by which it is secured at the top of the mast. Inside this socket is a removable insulating bushing which prevents grounding even if the wiring comes in contact with the case or if, by accident, the insulation of any current carrying parts of the mechanism is broken down. At the top of the case a similar socket is provided for the reception of the pinnacle, in case the signal is located at the top of the mast, or for the extension of the mast in case other signals are to be added. Any of the various semaphore spectacles now in use may be applied to the signal. While the design is simple and graceful the shape in no way interferes with the distinct indications of the semaphore arm.

The mechanism of the signal consists, primarily, of a motor, reducing gears, means for engaging and disengaging the signal shaft from the driving gear, means for preventing shock to the signal parts when the signal returns by gravity to its stop position, and the necessary electrical contact devices for securing the desired movements.

The motor differs from those used in other types of General Electric signals in that it is provided with both series and shunt field windings and a ball ratchet to prevent backward rotation of the armature. The circuit controller is also of the original type.

Attached to the inside of the frame is a case for protecting the high speed gear and the motor pinion. The intermediate gear and its pinion are protected by a case made of a single piece and bolted to the outside of the frame, making a water-proof joint. To the face of the main gear are attached driving pins of case-hardened steel which move the signal from stop to proceed position by engagement with the pawl of the slot-arm. The slot arm is mounted on a squared portion of the signal shaft by means of a broached-hole in its hub and carries a magnet, the armature of which is attached to one end of a bell crank lever. The other end of this lever is connected to a pawl which is drawn into position for engagement with the driving pins whenever the slot-magnet is energized. The series coil of the slot-magnet is connected in the motor circuit and the shunt coil is connected outside of the control contacts which break the motor circuit. Current is carried to the slot magnet without flexible moving wires, the connection being accomplished by means of segmental collector rings and brushes.

An eccentric is mounted on the signal shaft directly back of the main gear. The strap of this eccentric is cast in one piece with the cylinder of the dash-pot, or buffer, which is similar in principle and action to the ordinary door check. In front, connected to the main shaft, is located a device for registering the number of signal movements.

When the signal circuit is closed current will flow through the shunt coil of the slot-magnet, and in another circuit through its series coil, and thence through the

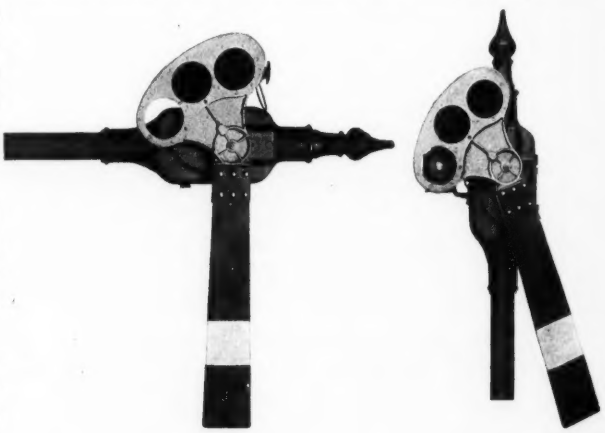


FIG. 1 FIG. 2

TOP MAST MOTOR SIGNAL

FIG. 3—SEMAPHORE MECHANISM

motor control sector and its contact fingers to the motor. The slot magnet being energized, the pawl is held in the path of the driving pins, and as the motor revolves one of the pins is forced against the pawl, thereby turning the slot-arm and the signal shaft to which it is connected. When the arm of the signal comes almost to its extreme position of proceed the motor current is broken by means of the controller, but this breaking of the current does not arrest the movement of the signal, on account of the inertia of the revolving armature and other parts. It is evident that, on account of the shunt field winding, the motor driven by its own inertia becomes a generator maintaining its field excitation. Immediately after the circuit between the motor and the battery is opened a low resistance circuit is closed between the motor brushes, thus converting the motor into a powerful electric brake to arrest the further movement of the signal. Any backward motion of the armature when the motor is stopped is prevented by the ball ratchet, so the signal is held in its clear position until the main circuit between the signal and the battery is opened.

The higher the voltage of the battery and the less the friction of the machine the greater will be the speed of the motor at the time the battery current is off, and the greater will be the inertia of the moving parts. The greater the speed of the motor the higher will be the E. M. F. generated in its armature and the greater will be the current opposing its forward movement when it is acting as a generator. Therefore, under all conditions, the motor will make approximately the same number of revolutions after its current is broken, stopping the signal arm at the same position. This arrangement eliminates the necessity of a friction brake, and at the same time secures much better results.

When the main signal circuit is opened and the slot-magnet de-energized, its heavy armature falls away from the poles, this movement being also assisted by the pressure of the driving pins against the pawl. The pawl being thrown back from engagement with the driving pin, the signal is free to assume the position to which it is normally carried by gravity. As the signal arm comes to its stop position, the rotation of the slot-arm causes its armature to swing back against the poles of the magnet so that it is in position to be held firmly in place when current is again applied.

This signal is specially designed for two-position work, yet it can be operated as a three-position signal when an extra circuit controller is used and a back contact provided on the line relay. Under these conditions, when indicating a back-up train movement, the signal will go from proceed to stop before assuming the caution position. There are many instances in three-position signaling in which such movement is not objectionable, and to such cases this signal is applicable.

Another feature in the design is that all parts are readily accessible and easily removed from the case when repairs or renewals are desired. Provision is also made for the proper lubrication of all parts. The motor and other parts are reversible to provide for upper and lower quadrant indications as desired.

Drainage of Roadbeds

Editor Railway Engineering:

Your article on "Causes of Roadway Deterioration" treats on the subject of drainage of roadbeds in which I am very much interested. I have therefore a few remarks to make, which may interest you and your readers.

My opinion is that an ideal roadbed is one which has a good foundation of crushed stone, gravel or hard material upon which is laid about a foot or more of crushed stone ballast and, in addition, is thoroughly drained by use of open ditches or tile as is necessary.

The depth of the foundation depends upon the condition of the ground. If it is a soft clay or quicksand the foundation should be several feet in depth. If lateral drains are used, I think they should be placed about two feet below the bottom surface of the ballast and should slope slightly. I believe it is good practice to use these

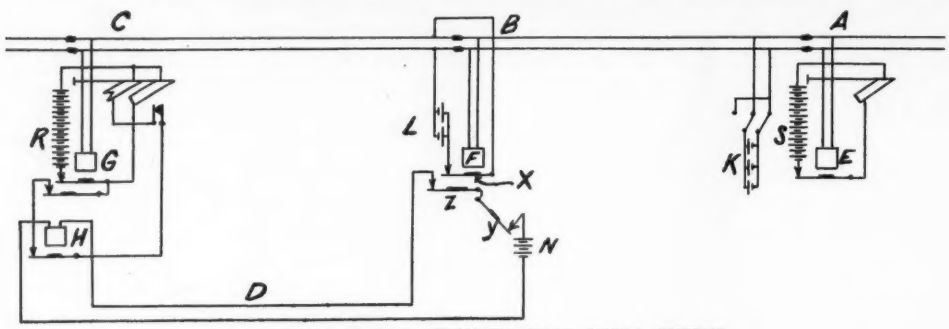


FIG. 2—TRACK CIRCUIT, AUTOMATIC BLOCK SIGNAL SYSTEMS

cross drains in deep cuts which have poor natural drainage. Everything should be done that will tend to keep the roadbed dry in those bad places. Drain tile should be laid about three or four below the lower surface of the ballast and about several feet from the end of the ties. The drain tile should have a fall of several inches to the hundred feet if it is possible to give that by varying its depth below the ballast. To keep the tile in position, I think it is necessary to use a wooden trough in which the tile is placed and covered with cinders. It would also be best to place the lateral tiles in troughs in order that they may be kept in working condition.

If a good roadbed is constructed at the start, there will be much less trouble in maintaining it as everyone knows. I hope that others will give their views through your columns, because every man meets different conditions in the work of track construction.

Yours truly, A. M. B.

Automatic Block Signal Systems

Chicago, Milwaukee & St. Paul Railway

SEVERAL typical track circuits of block signal systems, installed on the Chicago, Milwaukee and St. Paul road, are shown in the accompanying diagrams. Standard practice is represented in these track circuits.

The polarized system of distant signal control is shown

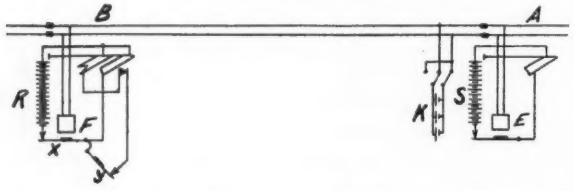


FIG. 1—TRACK CIRCUIT, AUTOMATIC BLOCK SIGNAL SYSTEMS

in Fig. 1. The wiring of last signal on the line is shown at A and of all other signals at B. The relay, F, has two armatures, x and y. The armature, x, is operated by a change in the amount of current flowing through the relay coils and is used for the control of the home signal. The armature, y, shifts the contact for the distant signal circuit, when the polarity of the relay is changed by a reversal of the direction of current in the track circuit. The reversal of current is caused by the advance home signal mechanism. When the home signal operates, the pole changer shifts the terminals of the battery, K. The distant signal is also controled through the contact of armature, x, at the home signal on the same post.

In Fig. 2 an arrangement is shown by which the track circuits are shortened. The operation of home signal at A reverses the polarity of the track circuit, B, and causes the armature, y, to open the line circuit, D, the distant signal being operated through the relay, H. When the train enters the track section, B, the armatures, x and y, open the track circuit, C, and line circuit, D, respectively and cause the home and distant signals at C to operate.

The distant signals may be controlled by line wires as in Fig. 3. The polarized armature is dispensed with in this system. The operation of the relay, E, on the track circuit, A, opens the home signal circuit at A. The line circuit, D, for the distant signal at C is opened by home signal circuit-breaker, T, at A. When the train is in track section, B, the relay, F, opens the track circuit, C, causing the operation of relay, G. Relay, G, opens the battery circuit of the signals at C.

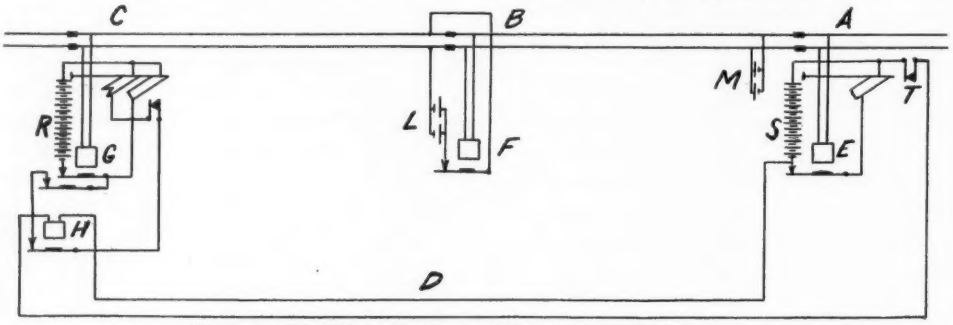


FIG. 3—TRACK CIRCUIT, AUTOMATIC BLOCK SIGNAL SYSTEMS.

Proportioning of Steel Railway Bridge Members*

By Henry S. Prichard, M. Am. Soc. C. E.

SEVERAL fundamental questions involved in proportioning steel railway bridge members are discussed in the article under the following captions: Available strength of structural steel; safe working stresses; rules for designing compression members; provisions for possible increase in live loads, and provision for the dynamic effect of the live load.

AVAILABLE STRENGTH OF STRUCTURAL STEEL

The conclusions, regarding the strength of structural steel, are based upon experimental data. These conclusions are summed up as follows: First, the available strength in either tension or compression is about 55 per cent of the ultimate tensile strength; second, under continuously alternating stresses of equal intensity, the available strength lies within the limits 35-45 per cent of the ultimate tensile strength, and, third, when long intervals of rest occur the strength is not impaired by occasional alternating stresses.

SAFE WORKING STRESSES

The recommendations for safe working are summed up as follows:

Safe working stresses for tension in main members, 16,000 pounds per square inch.

Safe loads on compression members, 15,000 pounds per square inch properly reduced for length.

Members liable to alternate stresses should be proportioned for each kind of stress separately considered, but each kind of stress should be regarded as increased by F per cent of the lesser kind, not including any increase on account of alternate stress from wind. When a member has riveted end connections, F should be 50; when it has pin ends, it should be 100.

Centrifugal force should be considered the same as life load and a corresponding addition should be made for dynamic effect.

RULES FOR DESIGNING COMPRESSION MEMBERS

During the last twelve years much attention has been devoted to the analysis of structural members in compression both under ideal conditions and the conditions of practice and many articles of great theoretical excellence have been published, notwithstanding which engineers are yet using formulas founded partly on the results of experiments and partly on false theories. In fact engineers in their practice, with regard to compression members, have profited very little from the increase in theoretical knowledge. This failure to obtain practical benefit from theory has been due partly to the fact that the theoretical column formulas are complicated and difficult to apply, partly to the fact that slight variations in the assumed conditions of practice make great differences in the results given by the formulas, and partly to the fact that considerations of stiffness make it necessary to prohibit long columns and reduce the allowed load on columns of moderate length, regardless of theory.

A good formula for compression members should be simple in its application; it should admit on occasion of allowance for intentional eccentricity or for transverse loading, such as a member's own weight; it should give results agreeing closely with theory for short members and allow loads somewhat less than allowed by theory for members of moderate length; it should provide an ample margin of safety as compared with the results of tests; and, to avoid flimsiness, it should gradually reduce the allowed unit load as the length increases, until it becomes zero at the limiting length. In regard to this last condition most of the formulas in use are quite faulty. What good reason is there for prohibiting the use of a column with an area of twenty square inches and a ratio of length to radius of gyration of 101, and allowing a column with an area of ten square inches and a ratio of 100 to be used to support a load of 86,000 pounds? This inconsistency is not unusual in bridge specifications.

Compression members take their names from their principal stress, but they are always liable to some bending stresses.

Bending stresses in compression members arise from three primary causes and one incidental cause. The primary causes are:

First—Prearranged or intentional eccentricity in the application of the longitudinal load; that is eccentricity that exists by reason of the design of the member and its connections.

Second—Transverse loading, such for instance, as a member's own weight.

Third—Defects in material, fabrication and erection; such as variation in elasticity and sectional area, which may shift the axis from the position assumed, and faulty alignment of the member. These defects exist to some extent in all compression members and by inducing deformation are highly detrimental, except for very short members.

The incidental cause is:

Deformation—This cause of bending stresses is unimportant for very short compression members, but its importance increases with the length of the member and is so great for long members that they will fail from this cause under loads which will produce only very small stresses from direct compression and primary bending moment.

Let B=area required for the primary bending moment.
D=area required for the incidental bending moment.
Z=variable factor, depending on the form of the moment diagram. If the cause of the primary bending moment is eccentricity, the value of Z may be taken as 1.234.
W=load producing the direct compression.
A=total area required for the cross-section of the member.
E=modulus of elasticity.
l=length of member in inches.
r=radius of gyration in inches.

*Extracts from paper in July proceedings of the Engineers' Society of Western Pennsylvania.

$$p = \frac{W}{A} \text{ and } q = \frac{^2E}{\left(\frac{l}{r}\right)^2}$$

$$D = B\frac{gp}{q-gp}Z$$

The area is not proportioned to the load, but it grows larger in proportion to the load as the load increases. It is therefore necessary to introduce a factor of safety, g, as regards the area required for the incidental moment. A good value for g is 3 in proportioning for the incidental bending moment.

Let p=the working load in pounds per square inch.

b=the compression per square inch from the intentional primary bending moment.

$$p = 15000 - b - \tfrac{2}{3}\left(\frac{l}{r}\right)^2$$

In determining the safe strength of a compression member in an existing structure, the value of p can be increased by a factor, K, say 25 per cent, and if the ends are evidently well fixed, the fraction 2/3 can be reduced to 3/8 on the assumption that the member is as stiff as it would be if it were only 3/4 as long and had frictionless hinged ends.

PROVISION FOR POSSIBLE INCREASE IN LIVE LOADS

The method of proportioning bridges not only for the specified live load with the specified unit stresses, but also for a 50 per cent increase in the live load with maximum safe unit stresses (say 25 per cent greater than those specified) and for a 100 per cent increase in the load, with unit stresses 100 per cent greater than those specified, is objectionable in practice for the reason that it necessitates the use of three sets of unit stresses and leaves it a matter of trial to determine which condition of loading is the governing one in proportioning each bridge member. Precisely the same result can be accomplished, using only the specified unit stresses, by making proper additions to the stresses to provide for possible increase in live load. The amounts to be added can be determined as follows:

Let D=the dead load stress.

L=the static stress from the specific live load.

I=the addition for dynamic effect of the specified live load; or briefly, impact.

P=the amount to be added to the live load stresses and impact to provide for possible increase in loading.

When live and dead load stresses are of the same kind—

$$\frac{L+I+D+P}{16{,}000} = \frac{1\tfrac{1}{2}L+1\tfrac{1}{2}I+D}{20{,}000}$$

$$P = \frac{L+I-D}{5}$$

When the live and dead load stresses are of opposite kinds—

$$\frac{L+I-D+P}{16{,}000} = \frac{1\tfrac{1}{2}L+1\tfrac{1}{2}I-D}{20{,}000} \text{ or } \frac{2L+2I-D}{32{,}000},$$

whichever gives the largest result

$$P = \frac{L+I+D}{5} \text{ or } \frac{D}{2}$$ whichever gives the largest result

Whatever may be the necessity for provision for increase in loading under present conditions, there is little doubt that had it been made twenty or twenty-five years ago, it would have prolonged the life of many a bridge.

The provision for possible increase in loading, is made chiefly in the stringers, floor beams and light truss members, and even if the increase in loading does not occur the provision may not be amiss, as an increase in the speed of trains may increase the impact in the members in question, and a little extra metal in the floor system may compensate for deterioration from rust.

PROVISION FOR THE DYNAMIC EFFECT OF THE LIVE LOAD

The rapid application of the load, the hammering of the counter-weighted driving wheels and the jolting and teetering of the engines and cars produce an effect on bridges from impact and accumulative vibration, the determination of which, even if all the governing conditions were known, is such a complicated problem that it is hopeless to attempt a theoretical solution, but some phases of the problem have been successfully analyzed and the conclusions to which the analyses lead are of assistance in considering the general subject:

The conclusions to which this analysis of the dynamic effect of the live load has led can be formulated as follows:

Let L=the static stress, moment or sheer from live load.

S=the length in feet of the loaded portion of the span.

N=the number of loaded tracks causing the maximum stress, moment or sheer.

U=the percentage of increase from dynamic effect.

I=the addition for dynamic effect of the live load: or briefly, impact.

$I = UL$.

The provision for the dynamic effect of the live load should be made by adding percentages as follows:

For a loaded length of span less than 125 ft.,

$$U = (100 - 0.4S) - 10(N-1)$$

For a loaded length of span from 125 ft. to 500 ft.

$$U = 50 - 10\,(N-1)$$

For a loaded length of span over 500 ft.

$$U = (100 - 0.1S) - 10\,(N-1)$$

The percentages for various loaded lengths are given in the accompanying table.

The greatest speed observed during the tests on which the foregoing rules are based was about 70 miles per hour. Greater speeds occasionally occur on some roads, and may become frequent on many roads, and such greater speeds carry with them the liability to greater impact on short spans. Inasmuch, however, as the provision for possible increase in live load, plus the provision for impact herein recommended, makes a greater addition to the static stresses in the floor system and light web members, than is customary, and inasmuch as greater speed and greater load may not both occur, it was not deemed advisable to make a general recommendation for a further increase over current practice. In special cases, however, it may be advisable to increase the provision for impact on short spans.

The dynamic effect of the live load at train speeds less than 20 miles per hour was found to be very small in the

Robinson, Turneaure and Baltimore & Ohio Experiments, which confirms the wisdom of the usual practice of running slowly over bridges known or believed to be unsafe. Orders for slow speed, apart from the inconvenience they cause, are not a satisfactory remedy for weak or overloaded bridges, as there is some danger that the orders will not always be heeded, but they are a precaution which, with care, may prolong the life of an old bridge.

PERCENTAGES OF INCREASE FROM THE DYNAMIC EFFECT OF THE LIVE LOAD

S Loaded Length of Span	Percentage of Increase No. of Loaded Tracks 1	2	3	4
0	100	90	80	70
5	98	88	78	68
10	96	86	76	66
15	94	84	74	64
20	92	82	72	62
25	90	80	70	60
30	88	78	68	58
35	86	76	66	56
40	84	74	64	54
45	82	72	62	52
50	80	70	60	50
55	78	68	58	48
60	76	66	56	46
65	74	64	54	44
70	72	62	52	42
75	70	60	50	40
80	68	58	48	38
85	66	56	46	36
90	64	54	44	34
95	62	52	42	32
100	60	50	40	30
105	58	48	38	28
110	56	46	36	26
115	54	44	34	24
120	52	42	32	22
125 to 500	50	40	30	20
520	48	38	28	18
540	46	36	26	16
560	44	34	24	14
580	42	32	22	12
600	40	30	20	10
620	38	28	18	8
640	36	26	16	6
660	34	24	14	4
680	32	22	12	2
700	30	20	10	0
720	28	18	8	0
740	26	16	6	0
760	24	14	4	0
780	22	12	2	0
800	20	10	0	0
820	18	8	0	0
840	16	6	0	0
860	14	4	0	0
880	12	2	0	0
900	10	0	0	0
920	8	0	0	0
940	6	0	0	0
960	4	0	0	0
980	2	0	0	0
1000	0	0	0	0

Rail Specifications

THIS progress report of the Special Committee on Rail Sections of the American Society of Civil Engineers will be acted upon at the next annual meeting of the society. The report is as follows:

Your committee respectfully report that they have given the report which they submitted under date of January 17, 1906, and which was referred back to them, careful consideration, and would now report that they are in consultation with committees representing other societies and organizations, as well as other interested parties, on the subject of modified rail sections, with the purpose of preparing and submitting to your society a new series of such sections.

In this designing of heavier sections, particular attention is being given to the advisability of increasing the percentage of metal in the webs and flanges, as compared with the existing sections recommended by your society. This they hope to accomplish in due time, and in the meantime respectfully submit to the society for its consideration the following specification for the manufacture of Bessemer and open hearth rails:

BESSEMER STEEL RAILS.

Process of Manufacture.—The entire process of manufacture and testing shall be in accordance with the best state of the art, and the following instructions shall be faithfully executed:

Ingots shall be kept in a vertical position in the pit heating furnaces until ready to be rolled, or until the metal in the interior has had time solidify.

No bled ingots shall be used.

There shall be sheared from the ends of the blooms formed from the top of the ingots not less than 25 per cent, and if, from any cause, the steel does not then appear to be solid, the shearing shall continue until it does. If, by the use of any improvements in the process of making ingots, the defect known as piping shall be prevented, the above shearing requirements may be modified.

The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass the temperature of the rail will not exceed that which requires a shrinkage allowance at the hot saws, for a 33-ft. rail of 100-lb. section, of 6 7-16 in., and 1-16 in. less for each 5 lb. decrease of section. These allowances to be decreased at the rate of 1-90 in. for each second of time elapsed between the rail leaving the finishing rolls and being sawn. No artificial means of cooling the steel shall be used after the rails leave the rolls, nor shall they be held before sawing for the purpose of reducing their temperature.

Chemical Composition.—Rails of the various weights per yard specified below shall conform to the following limits in chemical composition:

	70 to 79 lb. Percentage.	80 to 89 lb. Percentage.	90 to 100 lb. Percentage.
Carbon	0.50 to 0.60	0.53 to 0.63	0.55 to 0.65
Phosphorus shall not exceed	0.085	0.085	0.085

Silicon shall not exceed	0.20	0.20	0.20
Sulphur shall not exceed	0.075	0.075	0.075
Manganese	0.75 to 1.00	0.80 to 1.05	0.80 to 1.05

Drop Test.—One drop test shall be made on a piece of rail, not less than 4 ft. and not more than 6 ft. long, selected from each blow of steel. The test piece shall be taken from the top of the ingot. The rails shall be placed head upward on the supports, and the various sections shall be subjected to the following impact tests under a free falling weight:

70 to 79 lb. rail.....18 ft.
80 to 89 lb. rails.....20 ft.
90 to 100 lb. rails.....22 ft.

If any rail breaks, when subjected to the drop test, two additional tests may be made of other rails from the same blow of steel, also taken from the top of the ingots, and if either of these latter rails fail, all the rails of the blow which the represent will be rejected, but if both of these additional test pieces meet the requirements, all the rails of the blow which they represent will be accepted.

The drop testing machine shall have a tap of 2000 lb. weight, the striking face of which shall have a radius of not more than 5 in. and the test rail shall be placed head upward on solid supports 3 ft. apart. The anvil block shall weigh at least 20,000 lb., and the supports shall be part of, or firmly secured to, the anvil. The report of the drop test shall state the atmospheric temperature at the time the test was made.

Section.—The section of rail shall conform, as accurately as possible, to the templet furnished by the railroad company, consistent with the paragraph relative to specified weight. A variation in height of 1.64 in. less, or 1-32 in. greater than the specified height, and 1-16 in. in width, will be permitted. The section of rail shall conform to the finishing dimensions.

Weight.—The weight of the rails will be maintained as nearly as possible, after complying with the preceding paragraph, to that specified in contract. A variation of one-half of 1 per cent for an entire order will be allowed. Rails will be accepted and paid for according to actual weights.

Length.—The standard length of rails shall be 33 ft. Ten per cent of the entire order will be accepted in shorter lengths varying by even feet to 27 ft., and all No. 1 rails less than 33 ft. long shall be painted green on the ends. A variation of ¼ in. in length from that specified will be allowed.

Drilling.—Circular holes for splice bars shall be drilled in accordance with the specifications of the purchaser. The holes shall conform accurately to the drawing and dimensions furnished, in every respect, and must be free from burrs.

Straightening.—Care must be taken in hot straightening the rails, and it must result in their being left in such condition that they shall not vary throughout their entire length more than 5 in. from a straight line in any direction, when delivered to the cold straightening presses. Those which vary beyond that amount, or have short kinks, shall be classed as second quality rails and be so stamped.

Rails shall be straight in line and surface when finished—the straightening being done while cold—smooth on head, sawed square at ends, variation to be not more than 1-32 in., and prior to shipment shall have the burn occasioned by the saw cutting removed and the ends made clean. No. 1 rails shall be free from injurious defects and flaws of all kinds.

No. 2 rails shall be accepted up to 5 per cent of the whole order. They shall not have flaws in their heads of more than ¼ in., or in the flange of more than ½ in. in depth, and, in the judgment of the inspector, these shall not be so numerous or of such a character as to render them unfit for recognized second quality rail uses. The ends of No. 2 rails shall be painted white, and shall have two prick punch marks on the side of the web near the heat number brand, and placed so as not to be covered by the splice bars. Rails from heats which failed under the drop test shall not be accepted as No. 2 rails.

Branding.—The name of the maker, the weight of the rail, and the month and year of manufacture, shall be rolled in raised letter on the side of the web; and the number of the blow shall be plainly stamped on each rail where it will not subsequently be covered by the splice bars.

Inspection.—The inspector representing the purchaser shall have free entry to the works of the manufacturer at all times when the contract is being filled, and shall have all reasonable facilities afforded him by the manufacturer to satisfy him that the finished material is furnished in accordance with the terms of these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment.

The manufacturer shall furnish the inspector, daily, with carbon determinations for each blow, and a complete chemical analysis every 24 hours, representing the average of the other elements contained in the steel, for each day and night turn. These analyses shall be made on drillings taken from small test ingots. On the request of the inspector, the manufacturer shall furnish drillings for check analyses.

BASIC OPEN HEARTH STEEL RAILS.

The specifications for rails made by the basic open hearth process shall be the same as for Bessemer rails, excepting that a full chemical determination shall be furnished for each heat and two drop tests from each. Their chemical composition shall be:

	70 to 79 lb. Percentage.	80 to 89 lb. Percentage.	90 to 100 lb. Percentage.
Carbon	0.53 to 0.63	0.53 to 0.68	0.65 to 0.75
Phosphorus shall not exceed	0.05	0.05	0.05
Silicon shall not exceed	0.20	0.20	0.20

Sulphur shall not exceed	0.06	0.06	0.06
Manganese	0.75 to 1.00	0.80 to 1.05	0.80 to 1.05

The insistence of the railroad engineers on high carbons is exemplified in the above chemical requirements for open hearth rails. At present the Tennessee Coal, Iron & Railroad Company, which was first to roll open hearth rails on any considerable scale, is furnishing 0.50 to 0.60 carbon in rails of 70 to 80 lb., 0.55 to 0.65 carbon in 80 to 90 lb. rails and 0.58 to 0.68 carbon in 90 to 100 lb. rails. The Tennessee Company's phosphorus maximum is 0.06, and its manganese range differs from the above in having the maximum 1.05 per cent for 70 to 80 lb. rails to 1.10 per cent for heavier rails.

Washington Terminal Improvements

TO SIMPLIFY and minimize the number of construction problems, which, of necessity, would have to be met on a work of this magnitude, the entire layout was divided into three separate parts or divisions: The terminal depot building, the north approach and the south approach. To avoid confusion and controversy with the operating departments of the Baltimore & Ohio and Pennsylvania railroads, upon whose respective territories much of the work had to be done, the construction of the north approach and the depot building was assigned to the Baltimore & Ohio R. R., while the south approach and a portion of the Magruder Connection was assigned to the Pennsylvania R. R.

The north approach embraces the train yard of 33 tracks, power plant, express building, coach yard having a capacity of about 750 cars, engine and repair yards with the necessary engine house and shop facilities, together with the Metropolitan and Washington Branch connections for the Baltimore & Ohio R. R. and a portion of the Magruder Connection of the P. B. & W. R. R.

The south approach embraces the girder-covered work under the plaza, the tunnel under Capitol Hill and the connection with the P. B. & W. R. R. on Virginia Avenue.

THE TERMINAL.

The head house is 620 feet long and 220 feet deep. The concourse is 760 feet long and 130 feet wide, exceeding in length by about 9 feet the length of the Capitol. The height of the head house is from 65 to 120 feet and it is being built of white granite from Bethel, Vermont. The three central arches, 30 feet wide by 50 feet high, greatly exceed in size their Roman prototypes. At the east pavilion is a 40-foot arch carriage entrance, leading to a suite of rooms for use of the President and guests of the Nation. The west 40-foot arch carriage entrance leads to the general carriage porch, near the ticket and baggage lobby. The end pavilions and the central vestibule are connected by an open-air portico, which together form a continuous covered porch the entire length of the building.

The general waiting room is 130 feet wide and 220 feet long, covered by a Roman barrel vault, 90 feet high, decorated with sunken panels after the manner of the baths of Diocletian. A semi-circular window 75 feet in diameter at each end and 5 semi-circular windows 30 feet in diameter on the sides, serve to light it. The dining room, lunch room and women's waiting room are grouped at the east end of this hall; while the ticket office, baggage checking room, smoking and package rooms are grouped at the west end. Telegraph and telephone booths will be located in the general waiting room. Office space is provided on the second and third floors.

The main floor level will be about 35 feet above the average ground level in the vicinity. This, of course, implied some radical changes in the street elevations to provide ingress, to and from the station. This was effected in part by establishing in front of the station, a grand plaza 940 feet long, by feet wide, decorated with fountains, balustrades and terraces. From this space will lead nine separate and distinct streets and avenues, four of which are new, others with directions changed to better suit the scheme, the remainder unchanged except that the grades of all are changed to meet the new level. Owing to this change in elevation, many of the street changes will extend quite a distance from the plaza, particularly those streets leading to the west and south, while the changes eastward will be short owing to rising ground.

To create this plaza and fill the streets leading to it, requires about three-quarters of a million yards of material, while a similar quantity can be utilized in bringing to the level of the new streets, the low property adjacent. This generous supply of streets will provide ample facilities for the prompt handling of the traveling public, to and from the trains, and the spacious plaza will serve for massing spectators and troops who attend such public ceremonies as take place at the Nation's Capitol.

NORTHERN APPROACH.

The width of the terminal train yard is 760 feet or equal to the length of the concourse, one-half of which is located on either side of the center line of Delaware avenue. The tracks in this space will be divided into two groups or sections. One section of 480 feet will contain the stub or main floor level tracks; the other 280 feet will contain the through or low level tracks leading to the tunnel, the difference in elevation at the north line of the concourse being 20 feet. The main floor tracks descend northward from the Station to a point near K street on a grade of .55%; the low level tracks ascend to K street at the rate of .8% to a common level, from which point all tracks ascend at a .95% to Florida avenue. From this point north and eastward the rates of grade are as follows: The Washington branch connection of the Baltimore & Ohio R. R. Co. and the P. B. & W. connection of the Pennsylvania R. R. Co. continue at an ascending grade of .95%, the Metropolitan Branch at .7% and the Coach Yard at .5%.

Certain platforms in the high group are set aside for the exclusive handling of baggage, to avoid congestion of passengers and baggage trucks. Similar arrangements were planned for the low section, but to provide

more tracks the baggage platform feature was eliminated and baggage and passengers will both be handled on the same platform. The same method will be employed on those platforms on the high level, where no baggage platforms are provided. As some trains carry more baggage than others, as effort will be made to handle trains with heavy baggage, on tracks adjacent to the baggage platforms.

The terminal limits, between the concourse line and L street, are defined by retaining walls ranging from 5 to 35 feet in height, above the present ground. The high and low groups of tracks are also separated by a retaining wall, extending from the concourse to a point near I street, where the grades of the two groups of tracks very nearly coincide. The west retaining wall betwen the station building and the power house was constructed in such a manner, as to contain a tunnel 12 feet wide and 13 feet high, in which will be carried the heat, air, water and pressure pipes and the electric light and power wires. This tunnel was carried under H. Street and a branch tunnel 5 feet wide and 7 feet high was constructed along the north abutment of H street to carry the necessary pipes and wires to the Express building on the east side. In the top of the arch were placed I-beams, spaced 10-foot centers, the lower flange projecting about 6 inches below the soffit. Hangers from these I-beams will support the pipes which pass through the tunnel, while the electric wires will be c arried in conduits supported along the sides. The east retaining wall between H and I streets was designed to carry the girder work supporting the roadway on the east side of the express house at the track level, and also to act as a retaining wall for Second street between H and I streets which rises at the rate of about 4% to I street, the track level entrance to the express building. The sections of this wall, therefore, change as the conditions require.

All the other walls are of the ordinary design of retaining wall, except possibly a little heavier than the ordinary construction, due partly to the fact of unsuitable foundations and because of the use of sand stone facing and concrete backing, which makes a somewhat lighter wall than other kinds of building material. All retaining walls and abutments north of the depot are constructed in accordance with the Baltimore & Ohio R. R. specifications for second class masonry, all exposed faces being sandstone backed with portland cement. concrete. The stone facing is carried from 12 to 18 inches below the finished surface; all masonry below this line is of portland concrete.

Granolithic platforms will be built between the tracks in the train yard, although it is probable that this work will not be done until after the filled material has had ample time to settle. It is not proposed to build at this point in a regulation train shed, but instead to have over each platform an umbrella shelter. There will be 19 of these sheds, each about 700 feet in length, although the platforms will extend about 200 feet further and will be about 900 feet in length.

SOUTHERN APPROACH.

The southern connection is by tunnel, open cut and viaduct. Starting at the south line of the head house, about 525 lineal feet of girder covered way is constructed ranging in width from 115 feet at the north end to 36 feet at the south where it joins the twin tunnel. From his point southwardly, a distance of about 4000 feet, the construction consists of two tunnels built side by side, each tunnel being 16 feet wide and 17 feet high from top of rail to soffit of arch. The division wall between these two tunnels is constructed of coursed stone masonry 4 feet in thickness, and contains openings at intervals of 100 feet providing access between the tunnels and refuge niches for the protection of track men. The side walls and haunches are being constructed of concrete and the arches of five rings of brick. The conduits for the accommodation of the electric wires are being laid in the haunching as it is being constructed, access to which will be had by man-holes located above the spring line, at intervals of 400 feet. To prevent these tunnels from dampness, as far as possible, gutters are being constructed on each side some distance from the spring line of the arch, from which down spouts will lead to the sub-grade at intervals of about 50 feet. In constructing the side walls for this work, forms constructed of steel plates ¼ inch thick, 4 feet wide and 10½ feet high, stiffened with angle iron flanges on all edges and three horizontal angles dividing the height into four equal spaces, are used. These forms are held in place by timbers which extend across the width of the cut. The centres used in the construction of the arches are made of T shaped steel ribs, formed by riveting together two angles 4 x ½ inches, made in two sections joined at the crown by fishplates, and are held together by tie rods attached to angle flanges. The top and a portion of the sides will be waterproofed, with four layers of waterproofing felt laid in waterproofing compound. Upon this will be placed one inch of cement mortar for the open work and a layer of brick for the drift portion of this work. Of the tunnel constructed to date, practically all has been done by the cut and cover method.

Uniform and satisfactory progress was made in the construction of the south approach, a large percentage of which is tunnel and girder covered work. There are 525 feet of girder covered work which was built in open cut. Of the tunnel work, 2480 feet is drifted; the balance, 600 feet at the north end and 950 feet at the south end, was constructed in open cut. As no shafts were allowed the drift tunnelling was done from the south end. At this point all excavation was loaded on standard gauge cars to be removed by the railroad. Here was located the plant for mixing concrete and handling the other materials entering into the permanent construction. This plant, including the motive power for conveying the concrete to the work, was operated by electricity. The shovel used in excavating the mass of the material removed in building and tunnel was operated by compressed air. By the use of these appliances all smoke

and gases were avoided, allowing the workmen to perform their labors under the most favorable conditions without adding materially to the cost of construction. The remainder of this work consists of cut and embankment with bridges over intersecting streets.

There are several points worthy of special note in connection with this construction: First, the construction of two tunnels, side by side, separated by a dividing wall but 4 feet in thickness. The work on one tunnel, embracing a side wall and the middle wall with connecting arch, was carried on somewhat in advance of the other, after the custom in building single tunnels; the construction of the other side wall with its connecting arch then followed, completing the two-track tunnel. Second, the enormous amount of timber used in supporting the overlying material during the construction of the masonry.

The crown bar system of timbering was first employed in the removal of the earth from the space in which the arch was to be built. Segmental timbers were then placed inside the crown bars to strengthen the work. The timber is about 2 feet in thickness.

MARYLAND AND VIRGINIA AVENUES IMPROVEMENTS.

Starting at the Potomac river, the main line of the Pennsylvania R. R. occupies a walled cut in Maryland avenue and all streets are carried over. Near the intersection of Maryland and Virgina avenues, the tracks pass from a walled cut to an elevated structure which extends as far east as S. Capitol street and Virginia avenues. Over this portion of the line the streets are taken under the tracks. The roadbed for tracks on both these avenues is protected by retaining walls. Some street grade changes were necessary. From S. Capitol street and Virgina avenue to Second street and Virginia avenue, through Garfield Park the construction consists of a walled cut on the line of Virginia avenue, thence by double track tunnel to a connection with the present tracks near Virginia avenue and Ninth street.

B. & O. COAL YARD.

The space upon which the north approach to the Terminal is constructed, was covered with dwellings, warehouses, coal yards, freight yards and sheds, and the main tracks and sidings of the Washington and Metropolitan Branches of the Baltimore & Ohio R. R. Co. As previously stated the west end of the Station building is constructed on ground formerly occupied as a coal yard by the Baltimore & Ohio R. R. Co. As it was necessary to clear the ground for the Terminal construction, this Company was obliged to construct a new coal yard on square 711, bounded by M, 1st, N and 2d streets, N. E.

On this block was constructed six lines of trestle about 19 feet in height and 600 feet in length, having a capacity of about 60,000 tons. The tracks are arranged in pairs, spaced 52 feet centre to centre, with a 7 foot division fence located halfway between. Each trestle has its macadam roadway 33 feet in width. The trestle bents, stringers, ties and braces are all of Georgia yellow pine, while the bins are short leaf Georgia. All bents rest on concrete foundations ranging in depth from 3 to 14 feet, depending on character of foundation encountered. The ground and trestles are the property of the Baltimore & Ohio R. R. Co. and are leased to six of the largest coal dealers, located on the Baltimore & Ohio Railroad in Washington.

B. & O. FREIGHT TERMINAL.

The Union Station Act precluded the construction of a freight yard near the passenger station. The Baltimore & Ohio R. R. was therefore obliged to locate its freight terminal at New York and Florida Avenues. As indicated on the plan, the inbound house 50x600 feet is located parallel with and 35 feet west of New York Avenue. The outbound house 22x300 feet is also parallel with New York Avenue, but 120 feet northwest of the inbound house. In the space between these two houses are located two 10 foot platforms, one adjacent to each house; two 10 foot transfer platforms 600 feet long, between the groups of tracks; and 7 tracks, two pairs and one group of three, one pair adjacent to each house while the group of three is located in the middle of the space.

Northwest of the freight house are located the team or bulk freight tracks, 14 in number and about 1,200 feet in length. Between the inbound and outbound houses is located a two-story office building, 25x121 feet. At the end of the outbound house are located two tracks about 800 feet long(which are set aside for handling meats, at the end of the inbound house are two tracks, over which there has just been erected a gantry crane which will be operated by electricity. It has two hoists, a high speed of 10 tons capacity and a low speed of 25 tons. The capacity of the bulk yard is about 450 cars; the house tracks have a capacity of about 200 cars; and the storage yard which is being constructed between the old and new Metropolitan Branch lines, will have a capacity of about 600 cars. The tracks in this yard are divided into three groups, for convenience in handling business and also for the purpose of utilizing the ground to the best advantage.

It will be noted that there is a great difference between the areas of the two houses. This is accounted for by the fact that the percentage of business handled in Washington, is 80% inbound and 20% outbound. Washington is not a manufacturing city, but on the contrary, industries of this character are discouraged to such an extent that practically no manufactories exist.

COACH YARD, ROUND-HOUSE AND SHOPS.

Extending from the throat of the train yard near K street to the site of the round-house and shops, there are two tracks, set inside for the handling of equipment. These tracks connect near New York and Florida avenues with the coach yard, and from the Terminal Station to this point, will be used for the handling of all kinds of equipment. From this point to the round-house and shops, they will be used principally for the handling of locomotives to and from the round-house.

The coach yard is located between the Washington and Metropolitan main lines and the "Y" connection between them. This yard is designed for the accommodation of the different classes of equipment, which will be handled over the different roads using this Terminal, one portion of the yard being set aside for the care of Pullman cars, adjacent to which will be located the building for the accommodation of the car cleaners, and the housing of supplies, etc. The spaces between certain tracks are provided with covered platforms, to be used in connection with the cleaning of these cars.

From the space, which this yard occupies, was obtainable a large part of the material required to fill the space between the walls of the Terminal, around the foundations of the depot and the plaza with its street approaches. The average depth of cut over a large portion of this space reaches 50 feet, the maximum cut being 82 feet. The entire cut contains about 2,000,000 cubic yards of material consisting of clay and clay and sand mixed, of a character easily handled by steam shovels. Six 70-ton steam shovels have been engaged on this work, three of which are of the Bucyrus and three of the Vulcan type, each having a capacity of about 30,000 cubic yards per month. The excavated material was hauled on narrow gauge dump cars of 4 yards capacity in trains of 10 to 12 cars each, the average haul being about 1½ miles.

Northeast of the "Y" connection is located the roundhouse and shops and engine storage yard, the tracks leading to the same passing under the "Y" connection between the Washington and Metropolitan Branches of the Baltimore & Ohio R. R. Co. Considerable thought has been given to the arrangement of tracks in this yard to insure convenience and safety, as well as to prevent the fouling of important running tracks in operation.

The 25-stall engine houses are planned, each having its own turntable, each of which is accessible from both sides of the coal-wharf located a short distance west. The coal wharf consists of a series of bins provided with measuring devices, into which the coal is dropped direct from the drop-bottom cars. The approach to the bins is by the ordinary trestle incline. Two ash pits are provided with depressed ash tracks, so arranged that the tops of cars when standing on them, fall below the bottom of the pit, thus reducing the labor of handling the cinder.

The following contractors have been engaged on this work: Northern approach, grading and masonry, Mc Mullen & McDermott and Hoffman Engineering & Contracting Co.; steel work in bridges, Milliken Bros.; erection of steel work, Youngstown Construction Co.; Terminal Depot, foundation and granite work, Thompson-Starrett Co.; steel work, American Bridge Co.; power house and express building, exclusive of steel work, Jas. Stewart & Co.; steel work, American Bridge Co.; Southern approach, New York Continental Jewell Filtration Co.; improvements on Virginia and Maryland avenues and Magruder connection, Drake & Stratton Co.; Baltimore & Ohio freight and coal yards, grading, Stewart & Wilmoth; freight sheds and coal trestles, Edward Brady & Sons. All track laying will be done by the railroad companies.

Effect of Moisture on Wood

The effect of water in softening organic tissue, as in wetting a piece of paper or a sponge, is well known, and so is the stiffening effect of drying. The same law applies to wood. By different methods of seasoning two pieces of the same stick may be given very different degrees of strength.

Wood in its green state contains moisture in the pores of the cells, like honey in a comb, and also in the substance of the cell walls. As seasoning begins, the moisture in the pores is first evaporated. This lessens the weight of the wood, but does not affect its strength. It is not until the moisture in the substance of the cell walls is drawn upon that the strength of the wood begins to increase. Scientifically, this point is known as the "fiber-saturation point." From this condition to that of absolute dryness the gain in the strength of wood is somewhat remarkable. In the case of spruce the strength is multiplied four times; indeed, spruce, in small sizes, thoroughly dried in an oven, is as strong, weight for weight, as steel. Even after the reabsorption of moisture, when the wood is again exposed to the air the strength of the sticks is still from 50 to 150 per cent greater than when it was green. When, in drying, the fiber-saturation point is passed, the strength of wood increases as drying progresses, in accordance with a definite law, and this law can be used to calculate from the strength of a stick at one degree of moisture what its strength will be at any other degree.

Manufacturers, engineers, and builders need to know not only the strength but the weakness of the materials they use, and for this reason they are quite as much interested in knowing how timbers are affected by moisture as they are in knowing how they are weakened by knots, checks, cross-grain, and other defects. It is obvious that where timbers are certain to be weakened by excessive moisture they will have to be used in larger sizes, for safety. So far, engineers of timber tests, while showing that small pieces gained greatly in strength, do not advise counting on the same results in the seasoning of large timbers, owing to the fact that the large timbers usually found in the market have defects which are sure to counterbalance the gain from seasoning.

The Forest Service has just issued a publication entitled "The Strength of Wood as Influenced by Moisture," in which are shown the strength of representative woods in all the degrees of moisture from the green state to absolute dryness, and the effects of resoaking. This publication will be sent free upon application to the Forest Service, U. S. Department of Agriculture, Washington, D. C.

Prices on Track Materials, F. O. B. Chicago

TRACK SUPPLIES.

Steel Rail, 60 lbs. and over.....$28.00 per gross ton
Steel Rail, 30 to 45 lbs..... 34.00 per gross ton
Steel Rail, 25 lbs..... 35.00 per gross ton
Steel Rail, 20 lbs..... 36.00 per gross ton
Steel Rail, 16 lbs..... 37.00 per gross ton
Steel Rail, 12 lbs..... 38.00 per gross ton
Ties, 6x8x8 oak, 1st grade.....77c each
Ties, 6x8x8 oak, 2d grade.....67c each
Switch Ties .....$30.00 to $35.00 M. ft.

Angle bars, accompanying rail orders, 1907 delivery, 1.65c.; car lots, 1.75c. to 1.85c.; spikes, 2.10 to 2.20c., according to delivery; track bolts, 2.60c. to 2.70c., base, square nuts, and 2.75c. to 2.85c., base, hexagon nuts. The store prices on track supplies range from 0.15c. to 0.20c. above mill prices. Switch set per turn out, 60-lb. rail, $85 to $90.

OLD MATERIAL.

	Per Gr.	Per Ton
Old Steel Rails, rerolling.....	$16.75 to	$17.25
Old Steel Rails, less than 3 ft.....	17.00 to	18.00
Old Iron Rails.....	20.25 to	20.75

SHEET STEEL.

It is quoted for future delivery:

Tank plate ¼-in. and heavier, wider than 6¼ and up to 100 in. wide, inclusive, car lots, Chicago, 1.88c., to 2.08c.; 3-16 in., 1.98c. to 2.18c.; Nos. 7 and 8 gauge, 2.03c. to 2.23c.; No. 9, 2.13c. to 2.33c. Flange quality, in widths up to 100 in., 1.98c. to 2.08c., base for ¼-in. and heavier, with the same advance for lighter weights; Sketch Plates, Tank quality, 1.98c. to 2.18c.; Flange quality, 2.08c. Store prices on Plates are as follows: Tank Plate, ¼-in. and heavier, up to 72 in. wide, 2.20c. to 2.30c.; from 72 to 96 in. wide, 2.30c. to 2.40c.; 3-16 in., up to 60 in., wide, 2.30c. to 2.40c.; 72 in. wide, 2.50c. to 2.65c.; No. 8 up to 60 in. wide, 2.35c. to 2.45c.; Flange and Head quality, 0.25c., extra.

STRUCTURAL STEEL SHAPES.

Store quotations are unchanged at 2.05c. to 2.10c., and mill prices are as follows: Beams and Channels, 3 to 15 in., inclusive, 1.88c.; Angles, 3 to 6 in., ¼-in. and heavier, 1.88c.; larger than 6 in. on one or both legs, 1.98c.; Beams, larger than 15 in. 1.98c.; Zees, 3 in. and over, 1.88c.; Tees, 3 in. and over, 1.93c., in addition to the usual extras for cutting to extra lengths, punching, coping, bending and other shop work.

CAST IRON PIPE.

Quotations per net ton on Water Pipe, 4 in., $38 to $39; 6 to 12 in., $37 to $38; over 16 in., $36 to $37; with $1 per ton extra for gas pipe.

CEMENT.

Good grade Portland Cement, car lots....$2.00 per bbl.*

* (Four sacks per bbl. credited 10c. each when returned in good condition.)

SAND.

Bank sand, car lot.....$0.65 per yd.
Torpedo sand, cart lot..... 1.15 per yd.

CRUSHED STONE GRAVEL.

Crushed limestone, car lot.....$1.05 per yd.
Crushed gravel, car lot ..... 1.00 per yd.

Personals

Mr. W. L. Mattoon has recently been transferred from the position of division engineer on the Zanesville and Western and Corning Division of the T. & O. C. Ry's. and has accepted the position of principal assistant engineer under the chief engineer of the Hocking Valley and Zanesville and Western Ry's.

Mr. D. C. Holtsbery, formerly division engineer of the eastern division of the T. & O. C. Ry., with headquarters at Bucyrus, Ohio, succeeds Mr. Mattoon as division engineer of the territory above mentioned and Mr. R. P. Black, formerly with the Pennsylvania lines west of Pittsburg, in charge of some construction work on the Indianapolis division, succeeds Mr. Holtsbery at Bucyrus.

Mr. Parker S. Cott, formerly principal assistant engineer on the H. V. & Z. and Western Ry's., resigned to accept a responsible position with the Sunday Creek Coal Co., at Athens, Ohio.

Mr. E. L. Trowbridge has been appointed assistant to the engineer of construction of the Louisville & Nashville at Louisville, Ky., in place of Mr. H. W. Oliver, resigned.

Mr. L. Slattery has been appointed signal engineer of the Chicago, Indiana & Southern, with headquarters at Gibson, Ind., in place of Mr. Byron Layton, resigned.

Professor William Freeman Myrick Goss, who has just accepted the position of Dean of the College of Engineering of the University of Illinois, is an engineer well and widely known both in the educational world as well as in the field of scientific and practical engineering. Professor Goss was born in Massachusetts in 1859 and received his certificate of graduation from the Massachusetts Institute of Technology in 1879. He received the degree of Master of Science from Wabash College in 1884 and the honorary degree of Doctor of Engineering was conferred upon him by the University of Illinois in 1904. In 1879, he was called to Purdue University to organize there the department of practical mechanics. Since 1890, he has been Dean of the Schools of Engineering and Director of the Engineering Laboratory at Purdue. As a result of his successful work at that institution he has become recognized as an authority on many aspects of the steam engine and has won for himself an international reputation in the field of railway engineering. He is a member of the leading engineering and technical societies of the United States and is the author of several engineering books and various monographs of a scientific nature Professor Goss is to take up his work at the University of Illinois this month and will be Dean of the College of Engineering and Director of the School of Railway Engineering. This school is a newly organized one and the University intends to develop in it a complete and compre-

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and Maintenance of Way

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New Standard Cross Tie

THE standard practice in roadbed construction is similar to that of the Illinois Central Railroad, outlined elsewhere in this issue. Changes, however, referring particularly to the size of tie, are being agitated by roadmasters because they believe a cross-tie of increased bearing area will reduce the cost of maintenance of roadbed.

The present standard tie is a 6x8-in. by 8-ft. This tie has been used by the railroads for the past quarter century and is said to have given the most satisfactory service until the heavier rolling stock was placed on the roads. On account of the present weight, speed and frequency of traffic, it is recommended that a 7x9-in. by 9-ft. tie be used.

The bearing surface is 26.5 percent greater for the larger tie and for this reason it is claimed that the number of roadbed renewals would be reduced. The shocks, caused by the thrust of the drivers, are distributed, not effecting the ballast to such a great extent. The object is to obtain a tie of greater bearing area, but the depth of the tie is also increased to give it greater strength. The stress in the tie would be increased slightly if the same section were used, but due to the enlarged section the stresses are lower.

The smaller size of tie is advocated on account of the scarcity of timber. It is thought that in future years the supply will be even less and the demand will be greater. On account of the age of the timber which will furnish the 6x8-in. tie, a greater number of them will be obtainable.

The life of the heavier tie is longer, however, because respiking of the tie is less frequent on account of the fewer roadbed renewals. Respiking often renders a tie useless before disintegration occurs. Deterioration, due to the atmosphere, is about the same for all sizes of ties and therefore the life of the tie is not based thereon.

In conclusion it might be said that the increase in cost of timber for supplying the 7x9-in. by 9-ft. tie is more than balanced by the longer life of the tie and the decreased cost of maintenance of roadbed. In consideration of these points, it appears that the heavier tie would be the more economical and should therefore be adopted as a new standard for the lines with the heavier rolling stock of the present day.

Design of Railway Bridges

THE general principles, governing the theory of bridge design, have been known for a long time. The specifications for loading and for the unit stresses are very explicit. The calculation of stresses in chords, due to dead loads, live loads, etc., is very well understood. The stresses in the parts, which go to make up these members cannot, however, be calculated and must be assumed.

The falling of the Quebec bridge emphasizes this latter statement. The cause of the failure is generally thought to have been due to a failure of one of the

compression members. This chord was designed similar to all other compression members and, as far as unit stresses are concerned, these stresses were well below the elastic limit. The cause of the failure of this chord can only be surmised. It is very probable that the component parts did not act as a single member, thereby causing certain sections of the chord to be strained beyond the elastic limit. If this is really the cause, one cannot say with any assurance that large compression members made up of many parts, will act as a single unit in resisting loads.

In order to overcome the difficulty a factor of safety is usually given. This factor does not secure results, however, in the case of these large compression members because the factor of safety is given for the unit stresses in the member itself and does not effect the bracing and rivets of the chord.

A thorough understanding of the stresses in the bracing of chords can only be had by tests. The cost of this experimental data will be so high that it will probably have to be undertaken by the government. While government tests in all other lines have been very extensive, up to the present time it was not deemed necessary to make these tests on large compression members of railway bridges. The necessity has only recently been shown by the great disaster, the falling of the Quebec bridge.

The Engineering Convention

THE chief aim of the engineering convention is to secure standardization of design and construction. Engineers of experience are brought together from all sections of the country, whose knowledge covers the best practice in all matters. One must agree that in no other way can improved methods and design be secured.

The progress reports of the committees are supplemented by the discussions of the society members. Facts are brought out from the experience of one man which would otherwise have remained unknown to the engineering profession. The discussions at these conventions become heart to heart talks between the members. Each man carries away with him information which will be of intense practical value in the pursuit of his work.

Changes in old standards are often advocated on account of new experiences of the engineers. Engineering is a profession in which better and more economical designs are continually being brought out.

A feature of the convention, which is not generally thought of but which is really of great importance, is the association of the men engaged in the same class of work. The acquaintanceship, which is here formed, encourages intercommunication, allowing one man to make a request of another for certain information which he does not happen to have on hand.

An opportunity is also offered the society members of serving on committees. The chief advantage of this lies in the thorough investigation which they are called upon to make. It is an advantage because they must make a careful study of facts, thereby acquainting themselves sometimes with a new subject and adding to their store of knowledge. The appointment to a committee carries with it the privilege of inquiring into the experience of other members. It is a chance which should not be neglected, because in this age one cannot gain too much knowledge. It broadens the view of the engineer to grapple with new problems in his profession.

The value of the exhibits lies in the demonstration of the operation of new equipment. There is also an advantage of having the manufacturer explain the apparatus thoroughly. It is often the case that an engineer will learn from these exhibits that which will convince him of the efficiency of the apparatus. Every one will agree that the exhibition of its operation is the most convincing argument in favor of its adoption.

While many good results are secured from a convention, the most important one is the standardization which is done. The convention offers the best opportunity for this particular work, being an assemblage of the most interested persons.

Rail Question

IDEAL conditions have not as yet been attained in the design and manufacture of steel rails. There is continued controversy in regard to the section of rail and the method of manufacture. Almost every road has decided upon the weight of rail which should be suited to its traffic.

Present practice in regard to the weight of rail varies for the different roads throughout the country. In some cases a light rail will suffice for the weight of rolling stock, while in other cases the heavier rail from 85 to 100 pounds is essential. The tendency, however, is to increase the weight of rail, whether or not the weight of rolling stock actually demands it. There are several reasons for this, which are based primarily on cost of maintenance. With heavier rails, a smaller number of ties is necessary and repairs to the roadbed are reduced. Then again, the cost of a heavier rail is increased in a smaller ratio than the strength and stiffness of the rail. For this reason, it is thought that it will prove economical to increase the weight of rail to some extent.

Previous to the adoption of the standard A. S. C. E. rail section, there was a variety of designs. The results of experience were introduced into this A. S. C. E. design and it was thought at the time that the section would prove an ideal one. The chief trouble has come about through the proportions of metal which were allowed for the head, web and flange of the rail. In this standard design the proportions are 42 per cent for the head, 21 per cent for the web and 37 per cent for the flange. With this proportioning, it has been discovered that intense cooling strains are developed in the process of rolling the rail. Other designs have been suggested occasionally in which the proportion of metal in the flange and head are

the reverse of the A. S. C. E. section. Up to the present time, however, no definite action has been taken by the railroads in general as to a change of rail sections. In the near future, it is expected that the American Society of Civil Engineers will present a new design of rail section, as the matter is now in the hands of a committee.

The method of manufacture of steel rails has been specified by several engineering societies. The solidification of the ingots is a point to which particular attention has been given. It is required that the ingots should be allowed to cool sufficiently for the interior to become solid. In order to overcome piping, it has recently been decided that 25 per cent of the metal must be sheared off from the end of blooms which are formed from the top of the ingot. The specification for the chemical composition of the steel allows for a percentage of carbon varying between 0.50 and 0.65 per cent., increasing from a lower to a higher value with the weight of rail. The percentages of phosphorus, silicon and sulphur are limited to 0.085, 0.20 and 0.075 per cent. respectively. The proportion of manganese, which is allowed, varies between 0.75 and 1.05 per cent. These proportions refer to steel rails manufactured by the Bessemer process. A slight variation from above chemical composition is specified for rails manufactured by the basic open hearth process.

It is hoped that ideal conditions will be attained by the new specifications which are under consideration. The defects of the present design are very well understood and therefore the engineers will be able to cope with known difficulties.

Track Circuits for Illuminated Track Indicators

New York Central and Hudson River Railroad

A DIFFICULTY, which is sometimes met with in locating interlocking towers, is to obtain a clear view of the tracks. There are often-time many obstructions, such as other buildings, bridges and their supports, etc., which limit the view of the signalman, and thus make the operation of the interlocking unsatisfactory. The illuminated track indicator is a solution of this problem.

The diagram shows the locking circuits for High Bridge, New York, Tower "D," being the same plant in which the illuminated track indicator, here illustrated, is installed.

The relays, marked B, U, V, etc., are small polyphase induction motors. One phase of these motors is operated from the track and the other from the line. The motors and also the track transformers are usually placed in iron track boxes at the side of the track.

The relays, marked AR, BR, FR, etc., are located in a relay cupboard in the lower story of the tower. They are operated either by the polyphase motor relays or by secondary track relays, shown at F and A, which are themselves actuated by the motors. These relays, F and A, are located in relay boxes placed on the signal bridge.

The relays, AR, BR, FR, etc., mentioned above, control the lighting circuit of the illuminated track indicator, which is located above the interlocking machine in the upper story of the tower. These relays also control the locks for switches and signals, which are placed on the levers of the machine. These locks are operated by means of low voltage storage batteries, located in the battery house together with the 110-volt interlocking batteries. This is the only apparatus, with the exception of the interlocking machine proper, for which direct current is used.

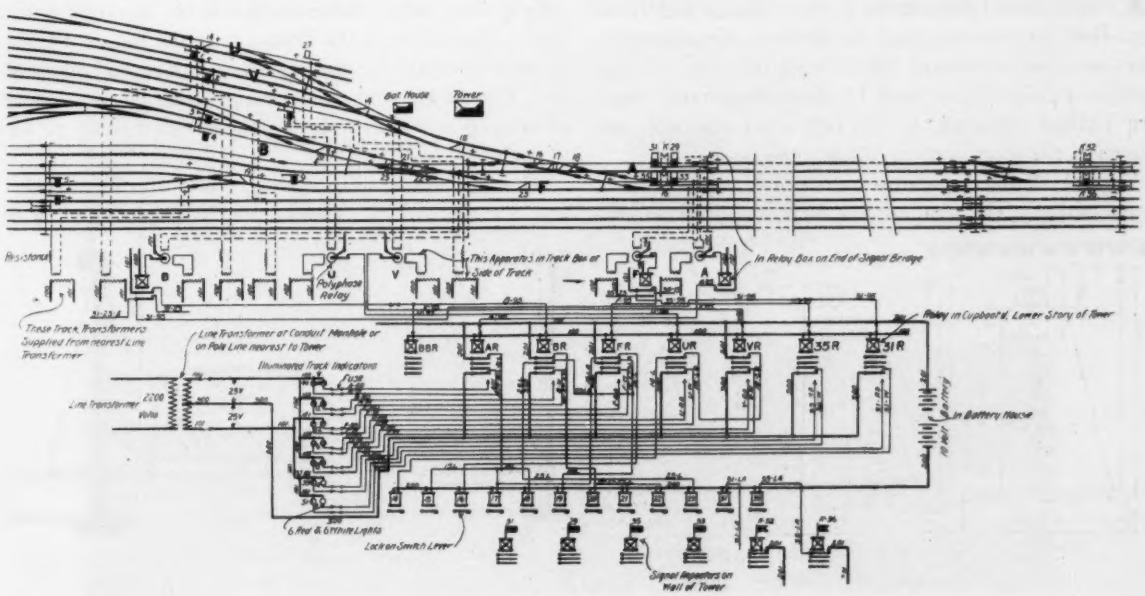
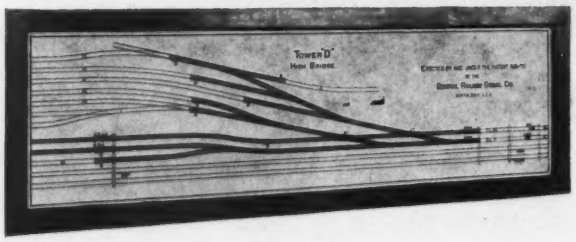

Boat House
Tower
Polyphase Relay
This Apparatus in Track Box at Side of Track
In Relay Box on End of Signal Bridge
Relays in Cupboard, Lower Story of Tower
These Track Transformers Supplied from nearest Line Transformer
Line Transformer or Conduit Manhole or on Pole Line nearest to Tower
Illuminated Track Indicators
Line Transformer 2200 Volts
25V
In Battery House
6 Red & 6 White Lights
Lock on Switch Lever
Signal Repeaters on Wall of Tower

DIAGRAM OF LOCKING CIRCUITS, HIGH BRIDGE, TOWER D, N. Y. C. & H. R. R. R.

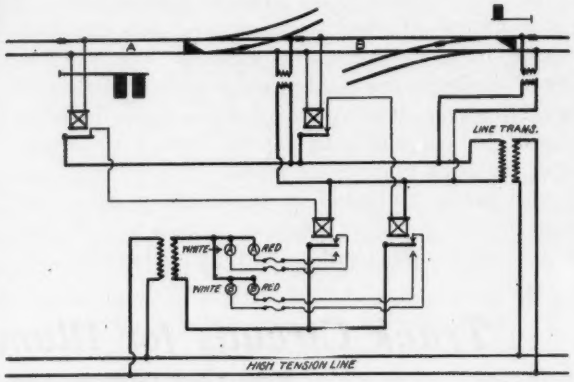


ILLUMINATED TRACK INDICATOR

In the wiring diagram for the illuminated indicator, shown below the track circuits, the figures between the red and white lights indicate the number of lamps in that particular section. Referring to track section "A" on the indicator, the circuit plan indicates only one red and one white light, the number 14 indicating the actual number of lamps which are placed 2 inches on center and wired in multiple. The number of lamps are determined by the length of the section, and consist of one-half red and one-half white lights.

A line transformer, having a voltage ratio of 2200 to 50-25, supplies the alternating current. The transformer may be located at a conduit manhole or on a pole line, depending upon whether distribution is by conduit system or aerial line. The nearest line transformer to the tower is used for supplying the current. As is shown there are 50 volts between secondary terminals, 100 and 101, and 25 volts between the middle tap and terminals.

When a track section is not occupied by a train, the current passes from one terminal of the line transformer through the track to one coil of the polyphase relay and back through the track to the transformer. The second coil of the relay is fed directly from the transformers. If a train occupies the track section the current is shunted from one phase of the relay.



TYPICAL CIRCUIT FOR ILLUMINATED TRACK INDICATOR

When a red light is shown on the indicator, the lock on the switch lever has also been closed, thereby preventing the operation of a switch under a moving train. The operation of the various relays may be easily understood by an inspection of the diagram of circuits.

The illuminated track indicator is a thin box with a glass cover, upon which is painted a plan of the tracks and the various signals. The numbers on the indicator correspond to the numbers of the levers, operating the same section of track.

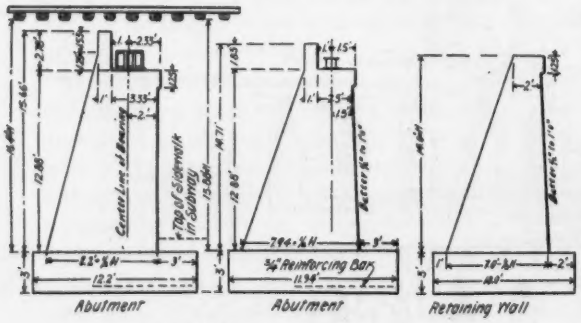
Track Elevation Details

C. & W. I. R. R.

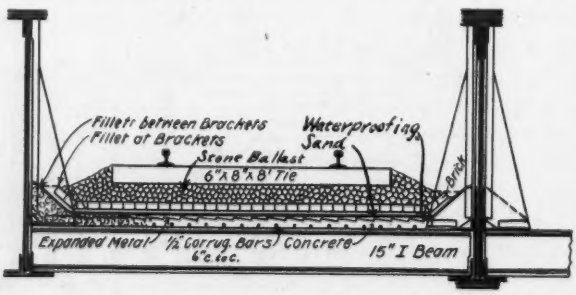
TRACK elevation work has been in progress for the past several years in the city of Chicago and vicinity. Both the structures and the methods of construction have assumed a standard form during this time. A few details of construction, used by the Chicago and Western Indiana Railroad, E. H. Lee, chief engineer, are shown in the accompanying illustrations.

Typical abutments and retaining wall are shown in cross-section. The abutments are of two different sections, one being used for grade crossings of deck girder type and the other for crossings of the through girder type. The width of the abutment at the top of footing is made one-half the distance from footing to bottom of tie. The width of the retaining wall at the top surface of footing is one-half the distance from footing to top of wall.

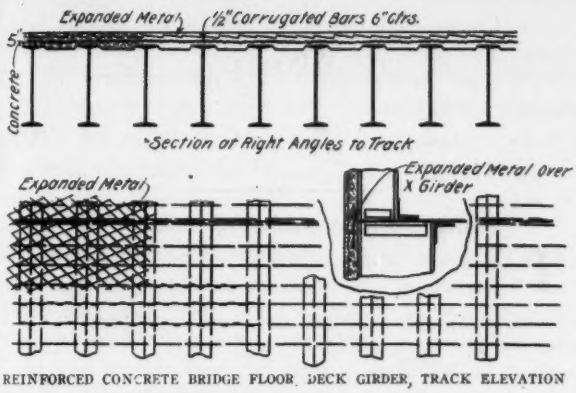
The reinforced concrete bridge floor with brick covering for the through girder type of grade crossing is



TRACK ELEVATION DETAILS



REINFORCED CONCRETE BRIDGE FLOOR, THROUGH GIRDER, TRACK ELEVATION DETAIL

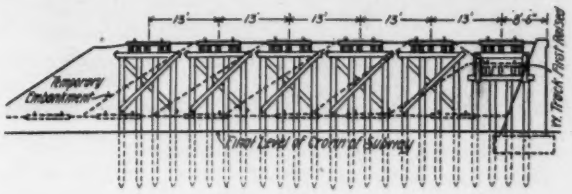


REINFORCED CONCRETE BRIDGE FLOOR, DECK GIRDER, TRACK ELEVATION DETAILS

shown in cross-section. The concrete is 5 inches in depth, being reinforced with ½-inch corrugated bars, spaced 6 inches on centers, and also expanded metal, placed 1 inch from upper surface of concrete. Waterproofing is laid on the concrete and is covered with a layer of sand upon which 2¼-inch brick is laid. Six inches of stone ballast is placed on the brick to support the 6x8-inch by 8-foot ties.

The reinforced concrete bridge floor for the deck girder type of grade crossing is shown in plan and section. The concrete is 5 inches in depth and is reinforced with ½-inch corrugated bars, placed 6 inches on centers, and expanded metal. The bars are placed 3¼ inches below top surface of concrete and the expanded metal, 1 inch below top surface.

A typical cross-section of subway is also given, which shows the method of elevating tracks. The first raise of



METHOD OF ELEVATING TRACKS, TRACK ELEVATION DETAILS

the west track was about ½ the full elevation. The second track from the west side was then raised to its full elevation. After this was completed, the first track on the west side was raised to its final elevation. The succeeding tracks were given the final elevation on the first raise.

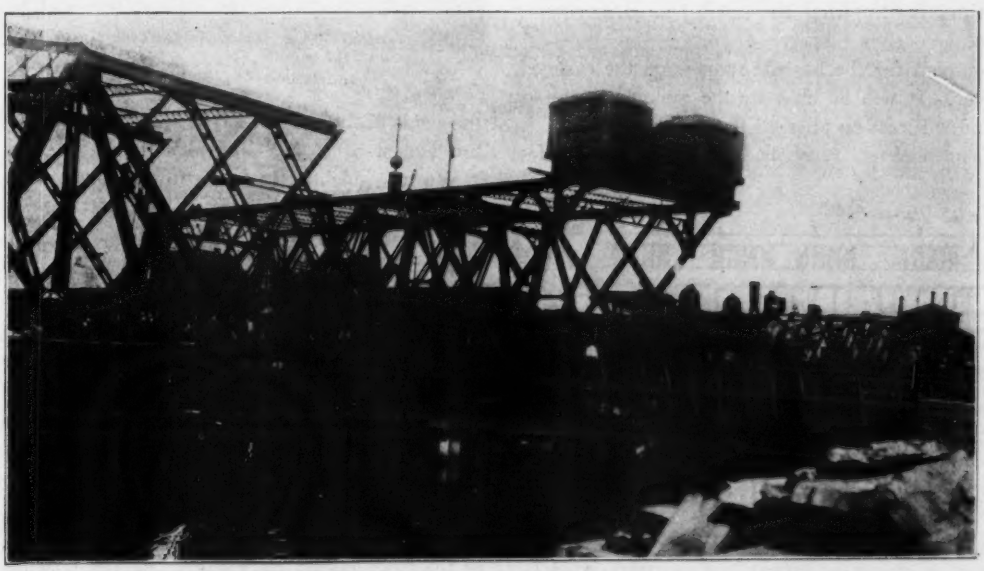
A Temporary Trestle

C. & N. W. Ry.

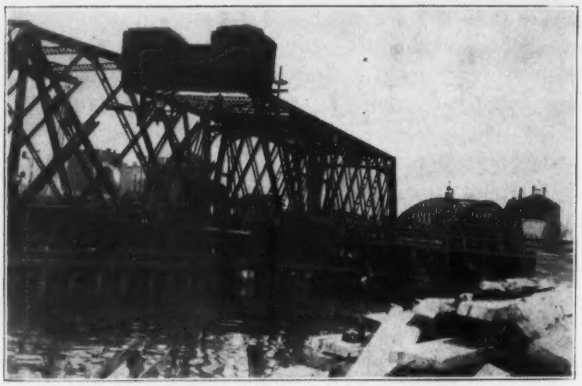
ON the Chicago and Northwestern road, the old center-pier bridge at Kinzie Street, Chicago, is to be replaced by a Strauss trunnion, bascule, single leaf bridge. In order to construct this new bridge, it was necessary to remove one arm of the center-pier bridge, which would swing over the abutment of the bascule, the center line of the bascule being only 50 feet south of the center line of the swing bridge.

The bridge is located immediately beyond the Wells Street station of the road. For this reason there were no terminal facilities at this point as long as the bridge remained in the open position. The temporary trestle had to be erected with great speed. The task was accomplished between the hours of 9:40 a. m. and 5:30 p. m., during which time traffic was suspended.

The bridge was swung into the open position and a section of the south arm was severed with hack saws and air drills. This section of the bridge was blocked up



KINZIE STREET BRIDGE IN CLOSED POSITION, SHOWING TEMPORARY TRESTLE



KINZIE STREET BRIDGE IN OPEN POSITION

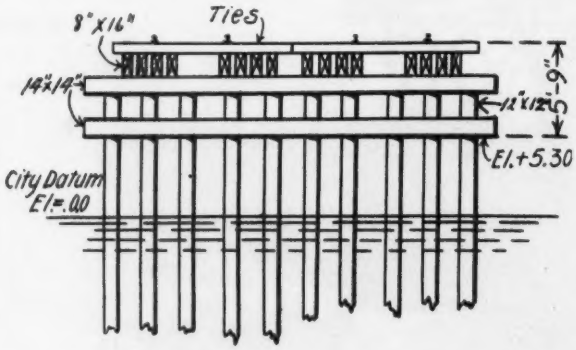
on the south protection pier, being dragged about a foot to the south. The weight of the unshortened end had to be counterbalanced and, therefore, 165 tons of pig iron were hoisted into securely bolted wooden boxes resting on transverse struts of I-beams which were placed at the extreme ends of the top chords. This work was accomplished with a large floating derrick by the Great Lakes Dredge and Dock Company.

By means of the derrick, caps and stringers were placed for the temporary bridge on the piling which had already been driven. The timber had been cut and could be spiked in place by gangs of laborers, working from scows in the river.

The trestle is about 73 feet in length and 28 feet in width, carrying two tracks from the shore line to the remaining section of the center-pier structure. It is constructed as shown in the sectional plan and the illustrations. There is a flooring across the ties between the rails and a railing on each side.

The present arrangement gives a clear channel of 56 feet on the west side of the river as before. When the bascule bridge is completed, there will be a clear channel of 100 feet.

The abutment for the bascule span is on the east side of the river. It will be built by the pneumatic caisson process and will rest on piles 18 feet below Chicago City datum. The pier will reach bed rock, which is 95 feet below Chicago city datum. The abutment will be constructed of plain concrete.



SECTION OF TEMPORARY TRESTLE, KINZIE STREET BRIDGE

The plans were prepared under the direction of E. C. Carter, chief engineer. The work was in charge of W. H. Finley, assistant chief engineer, assisted by I. F. Stern, bridge engineer.

Inspection Car, Southern Railway

THE motor car, here shown, is in use on the St. Louis division of the Southern Railway. It was purchased from the Fairbanks-Morse Company three years ago and has given good service. It was, however, recently rebuilt in the railway company's shops, the car now having a two-cylinder water-cooled Buick engine of the 1906 type.

The car can attain a speed of 50 miles per hour. It has made several long trips, 150 miles being the longest continuous trip. The car handles very nicely and will start from rest and attain a high rate of speed in a few rail lengths. It can be stopped from a speed of 45 miles per hour within a distance of 150 feet. The weight of the car is about one ton. It is never operated on the main line except by a "31" train order.

INSPECTION CAR, SOUTHERN RAILWAY

We are indebted to C. C. Coffee, superintendent, for the above data and accompanying illustration.

The Engineering Experiment Station of the University of Illinois has just published bulletin No. 13, "An Extension of the Dewey Decimal Classification applied to Architecture and Building." This greatly extended classification has been in use in a more comprehensive form in the department of Architecture for many years, but it has never before been published. It forms a supplement to the extended classification applied to the branches of engineering previously issued in Bulletin No. 9.

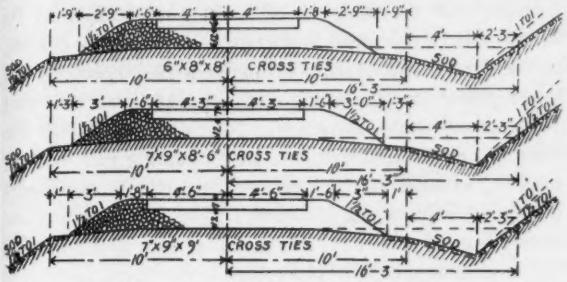
Copies may be secured upon application to the Director of the Engineering Experiment Station, Urbana, Illinois.

Standard Roadbed Cross-Sections

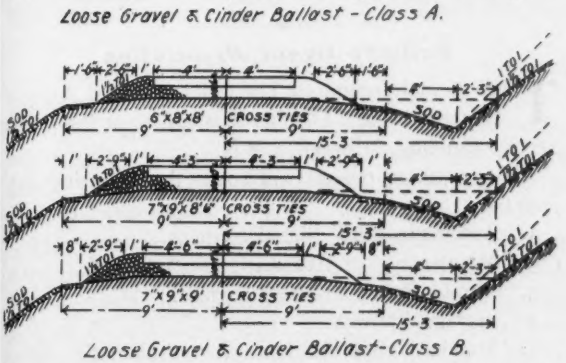
Illinois Central Railroad

THE standard roadbed cross-sections, which have been adopted by the Illinois Central Railroad, are shown below. These sections represent the present practice in roadbed construction on this road.

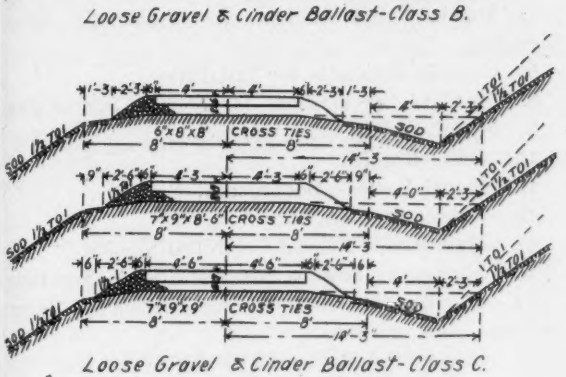
The use of one of the several classes of roadbed, A, B, or C, depends upon the importance of the section of line with regard to speed, weight and frequency of traffic. The sections of class A are used on the important main lines, the through lines for passenger and heavy freight service. Those of class B are used on main lines also, but lines which are of lesser importance. Class C sections are used only on branch lines of the road.



Loose Gravel & Cinder Ballast - Class A.



Loose Gravel & Cinder Ballast - Class B.

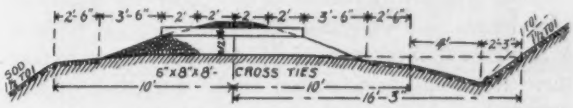


Loose Gravel & Cinder Ballast - Class C.

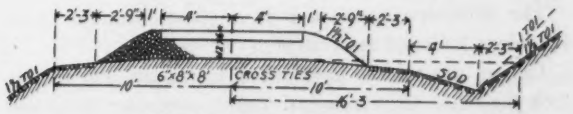
STANDARD ROADBED CROSS-SECTIONS

The variation in the different classes is in the width of roadbed and depth of ballast. Class A section has a 20-foot width of roadbed, class B has an 18-foot and class C has a 16-foot. There is a depth of ballast of 12 inches for class A, 10 inches for class B, and 8 inches for class C.

Different sizes of ties are used on several sections of the road. The standard tie for new lines is the 6x8-inch by 8-foot. The 7x9-inch by 8½-foot tie is used on a section of line upon which the tie was already laid at the time of purchase by the I. C. R. R. The 7x9-inch by 9-foot tie is a cypress cross-tie which is used in the states of Louisiana and Mississippi, the southern extremity of the road.



Cementing Gravel Ballast - Class A

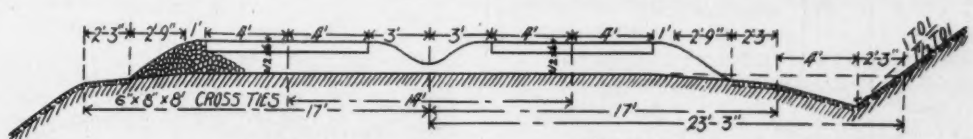


Rock Ballast - Class A

STANDARD ROADBED CROSS-SECTIONS

The ballast, to be used, depends on the location of the section of the road with respect to the source of supply. Rock ballast, cementing gravel ballast and loose gravel and cinder ballast are the kinds which are used, depending upon the importance of the line. The cementing gravel ballast is a mixture of gravel and clay, which gives a compact roadbed.

The illustrations show the various sections for all classes of loose gravel and cinder ballast, one section of class A for rock ballast and cementing gravel ballast, and one section for class A double track roadbed section. All double track sections are of class A, which has a 34-foot roadbed with 12 inches of either rock or loose gravel and cinder ballast below the tie. Only one section is shown for rock ballast and cementing gravel ballast, because the variation in detail corresponds to the sections for the loose gravel and cinder ballast.



Rock Ballast - Class A. Double Track

STANDARD ROADBED CROSS-SECTIONS

New Design of Rail Section

THERE is a feeling among many engineers that the ideal section of rail is not had in the standard A. S. C. E. section. It is thought that metal should be taken from the head and put into the flange in order to reduce the cooling strains, which are set up in the process of rolling on account of the unequal rate of cooling in the two parts.

The section, which is here shown, is a recent design by Captain Robert W. Hunt. More metal has been used in the flange than in the head. In fact, the proportions of metal in head and flange are nearly the reverse of those in the A. S. C. E. section, while the metal in the web is increased.

The width of rail is less, but the height is greater than in the A. S. M. E. section; the height of web and thickness of flange being increased and height of head being decreased. The center of gravity of the rail is lowered, the moment being increased.

In the August, 1907, issue of this paper, the results of experiments on a wide-base rail by the Atchison, Topeka & Santa Fe Railway were given. It would be well to take these tests into consideration in the discussion of this new design which is of the narrow base type.

The University of Illinois

The following news item is a communication from President James of the University of Illinois:

During the middle ages when European universities took their rise, the coming of a great professor to a state was considered one of the important events in the life of the community. When the University of Leyden was founded by the Dutch States General as a reward to the citizens of Leyden for withstanding the long siege of the Spaniards, thus saving Holland from subjugation, invitations were extended to the most eminent professors in the universities of other countries to accept chairs in the new institution. Delegations were sent by the government to persuade the men who had received these calls to accept them. When they responded to the calls they were recived with open arms not merely by the university circle, but by the citizens—men, women, children, old and young, rich and poor, of Leyden and Holland. Their coming was greeted with bonfires, illuminations and celebrations such as we give to great and important events.

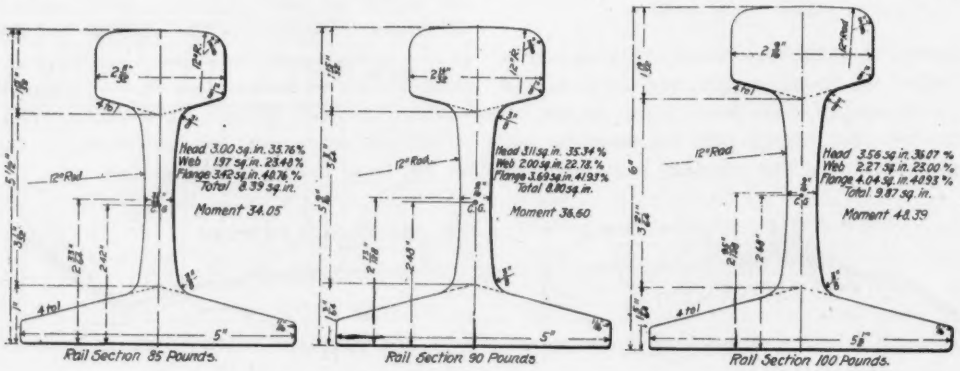
Those days have passed away never to return, but the significance of the coming of a great man into a community has not become less but much greater as the years have rolled on. The modern university is a much more comprehensive institution than the medieval. It reaches more sides of the community life and is more vital to its welfare, and the addition of each great scholar to its force is therefore more important. Prof. Goss's coming to the University of Illinois marks a new epoch in the development of engineering study in every branch of that work at our state university. In combination with the men who have organized and are conducting this work at present, we shall have, I believe, one of the strongest groups of engineering professors to be found in any institution in the world. I am sure that you, as a friend of the University, will be pleased to know these facts.

Railway Signal Association

THE annual meeting of The Railway Signal Association will be held October 8, 9 and 10 at the Public Service Building, Milwaukee, Wis.

The committee reports will cover the following subjects:

1. Automatic Block Signal Systems.
2. Maintenance of Automatic Block Signals.
3. Circuits for Interlocked Signals.
4. Storage Battery.
5. Standard Specifications for Automatic Block Signaling.
6. Costs in Estimates for Installation.
8. Standard Specifications for Electric Interlocking.
9. Signal Definitions.
10. Office Records.
11. Signal Lamps—Design, etc.
12. Rubber Covered Wire.
13. Maintenance Manual Controlled Signals.
14. Foreign Current on Automatic Block Signaling.
15. Standard Specifications for Mechanical Interlocking.
16. Circuits for Manual Block Signal Systems.


Head 3.00 sq. in. 33.76%
Web 1.97 sq. in. 23.40%
Flange 3.42 sq. in. 40.76%
Total 8.39 sq. in.
Moment 34.05
Rail Section 85 Pounds.
Head 3.11 sq. in. 35.34%
Web 2.00 sq. in. 22.78%
Flange 3.69 sq. in. 41.93%
Total 8.80 sq. in.
Moment 38.60
Rail Section 90 Pounds.
Head 3.56 sq. in. 36.07%
Web 2.27 sq. in. 23.00%
Flange 4.04 sq. in. 40.93%
Total 9.87 sq. in.
Moment 48.39
Rail Section 100 Pounds.

NEW DESIGN OF RAIL SECTION

Tie Plates and Wooden Foot Guards

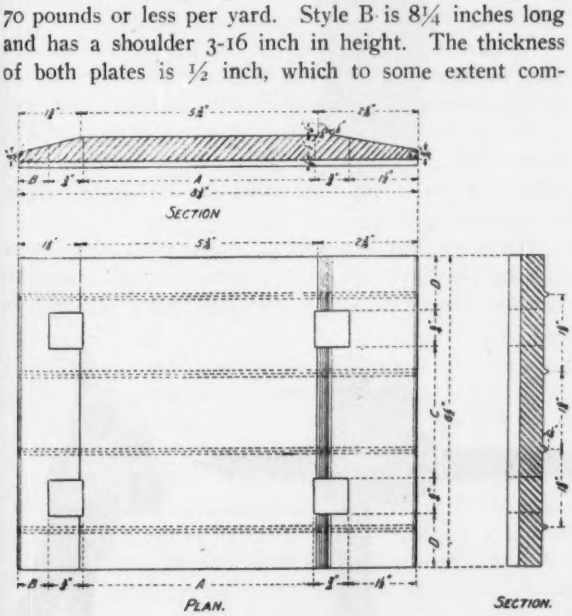
Chicago, Rock Island & Pacific Ry.

TIE plates give additional life to the ties, particularly those of the softer woods. They are used as a preventative for rail-cutting and spike-killing, which are serious troubles in maintaining the track. On curves they are used to advantage against the overturning of the rail due to lateral pressure on the head, which in turn causes rail-cutting at the outer base of rail. It is estimated that tie plates add four or five years to the life of soft wood ties and at least one or two years to the life of hard wood ties.

In the accompanying illustration, a standard tie plate of the Chicago, Rock Island & Pacific Ry. is shown. This plate was recently designed by the engineering department, J. B. Berry, chief engineer. The flanges on this plate are only ⅛ inch in depth, being much shorter than the older design. The plate is punched for four spikes.

The shorter depth of flange should give sufficient resistance between the plate and tie. It can be set much easier than the plate with deep flanges, which required a heavy sledge to set firmly. If the plate was not set firmly, it was of little value, giving excessive play to the plate and the spikes.

The tie-plate, here shown, is of style "A," which is used for rails weighing over 70 pounds per yard. Style "B" is similar in design and is used for rails weighing 70 pounds or less per yard. Style B is 8¼ inches long and has a shoulder 3-16 inch in height. The thickness of both plates is ½ inch, which to some extent compensates for the short flanges. The positions of the spike holes varies with the width of rail base, as shown in the table.



VALUES OF C & D

RAIL SECTION	ANGLE BAR	C	D
85 & ASCE	85040	2⅝	1⅛
80 "	80040	2½	1⅛
" Rounded	80048	2½	1⅛
75 ASCE	75048	3¼	

TABLE OF VARYING DIMENSIONS FOR STYLE A PLATE:

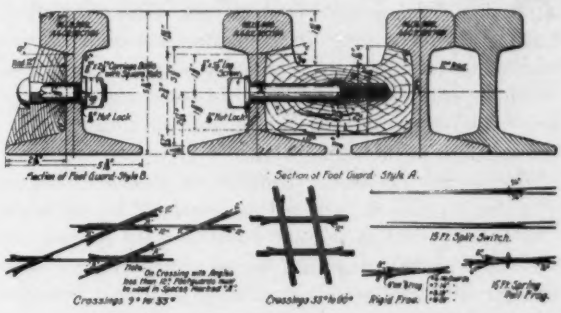
	RAIL SECTION.				
	80 LB. ASCE	80 LB. ASCE	75 LB. TRISCO	70 LB. ASCE	60 LB. ROUNDED HEAD PROPOSED
A =	5⅛"	4¾"	4½"	4⅜"	4⅛"
B =	⅞"	⅞"	1⅛"	1⅛"	1⅛"
C =	Head corresponds with staggering of spike holes in the Angle Bars				
D =	11(64"-[C+B"])				
	All other dimensions to remain as shown on drawing.				

STANDARD TIE PLATE, C., R. I. & P. RY.

The standard footguards are made of straight grained, well-seasoned oak or hard wood. These foot guards are cut to length, shaped to fit the rail section and bored for bolts before they are furnished to the track foreman.

Where foot guards are used they must be placed in frogs, crossings, guard rails, at heel of switches and all other points in the track, if the clear space between rail heads is more than three inches or less than five inches.

Two styles of foot guards are shown in the illustration.


Section of Foot Guard. Style B.
Section of Foot Guard. Style A.
15 Ft. Split Switch.
Crossings 9° to 33°
Crossings 33° to 90°
Rigid Frog.
15 Ft. Spring Rail Frog.

STANDARD FOOT GUARDS, C., R. I. & P. RY.

Style A foot guards are used where the web of one rail, to which the guard is to be applied, is inaccessible on one side. Style B footguards are used where the web of rail is accessible on both sides. It will be noted that a ⅝x5½ inch lag screw is used with Style A, while a ⅝x2⅞ inch carriage bolt is used with Style B. The foot guards are made both right and left-handed to suit conditions. The bottom of guards are notched by the track men to fit over the track spikes.

The application of the two styles of foot guards is shown in the drawings. For the 15-foot switch, the guard is 58 inches long and for the 24-foot, 90 inches long. Where necessary they are made of two pieces of style B for the split switch.

Association of Railway Superintendents of Bridges and Railways

THE seventeenth annual convention of the Association of Railway Superintendents of Bridges and Buildings will be held October 15, 16 and 17 at the Republican House, Milwaukee, Wis. All railway officials who are interested in the work of the association are invited to attend.

The subjects for report and discussion are as follows:

1. Experience in Concrete Bridges, Arches and Subways.
2. Concrete Building Construction.
3. Experience as to Expansion and Contraction of

Concrete Walls, either Reinforced or Plain Concrete.

4. Action of Sea Water on Concrete.

(a) Concrete made in Air and Sunk into Sea Water.

(b) Concrete Deposited Direct into Sea Water.

5. Recent Experience in the Use of Wooden and Asbestos Smoke Jacks for Engine Houses.

6. Combination Fastening and Lock for Rolling and Sliding Doors.

7. Construction of Towers and Guides for Lights on Draw Bridges.

8. Recent Experience in Protecting Steel Railroad Bridges Against the Action of Salt Brine from Refrigerator Cars.

The standing subjects, upon which committees will report, are as follows:

1. Pile and Frame Trestle Bridges.
2. Water Supply.
3. Fire Protection.
4. Fences, Road Crossings and Cattle Guards.
5. Preservatives for Wood and Metal.

The committee on entertainment will distribute a program at the convention, giving detailed information as to the side trips which are to be made. Several very interesting trips have been planned.

The program includes a morning and afternoon session on Tuesday, October 15, and Wednesday, October 16, and a morning session only on Thursday, October 17.

New Top-Mast Motor Signal

A NEW two-position top-mast electric motor signal has been brought out by the General Electric Company after a long and complete test under severe weather conditions. In outward appearance this signal is similar to the Company's three-position signal. Several new and interesting mechanical and electrical features are apparent in the signal shown in Figures 1 and 2.

The signal mechanism complete is shown in Figure 3 in the position of "proceed" as indicated by the blade. The bearings for the signal shafts and the gearing are concealed in the supporting frame which with the large door at the back forms a weather-proof case. A socket is located at the bottom of the case by which it is secured at the top of the mast. Inside this socket is a removable insulating bushing which prevents grounding even if the wiring comes in contact with the case or if, by accident, the insulation of any current carrying parts of the mechanism is broken down. At the top of the case a similar socket is provided for the reception of the pinnacle, in case the signal is located at the top of the mast, or for the extension of the mast in case other signals are to be added. Any of the various semaphore spectacles now in use may be applied to the signal. While the design is simple and graceful the shape in no way interferes with the distinct indications of the semaphore arm.

The mechanism of the signal consists, primarily, of a motor, reducing gears, means for engaging and disengaging the signal shaft from the driving gear, means for preventing shock to the signal parts when the signal returns by gravity to its stop position, and the necessary electrical contact devices for securing the desired movements.

The motor differs from those used in other types of General Electric signals in that it is provided with both series and shunt field windings and a ball ratchet to prevent backward rotation of the armature. The circuit controller is also of the original type.

Attached to the inside of the frame is a case for protecting the high speed gear and the motor pinion. The intermediate gear and its pinion are protected by a case made of a single piece and bolted to the outside of the frame, making a water-proof joint. To the face of the main gear are attached driving pins of case-hardened steel which move the signal from stop to proceed position by engagement with the pawl of the slot-arm. The slot arm is mounted on a squared portion of the signal shaft by means of a broached-hole in its hub and carries a magnet, the armature of which is attached to one end of a bell crank lever. The other end of this lever is connected to a pawl which is drawn into position for engagement with the driving pins whenever the slot-magnet is energized. The series coil of the slot-magnet is connected in the motor circuit and the shunt coil is connected outside of the control contacts which break the motor circuit. Current is carried to the slot magnet without flexible moving wires, the connection being accomplished by means of segmental collector rings and brushes.

An eccentric is mounted on the signal shaft directly back of the main gear. The strap of this eccentric is cast in one piece with the cylinder of the dash-pot, or buffer, which is similar in principle and action to the ordinary door check. In front, connected to the main shaft, is located a device for registering the number of signal movements.

When the signal circuit is closed current will flow through the shunt coil of the slot-magnet, and in another circuit through its series coil, and thence through the

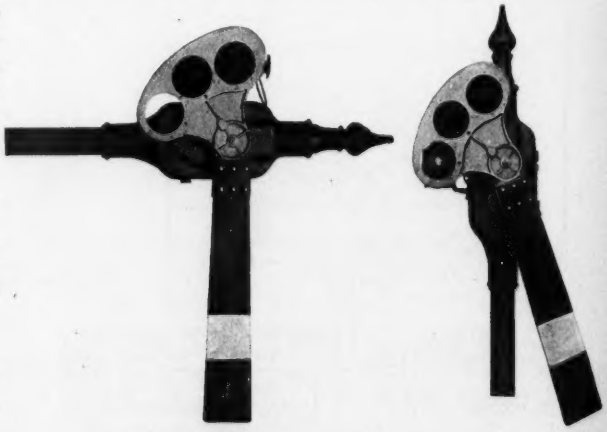


FIG. 1 FIG. 2

TOP MAST MOTOR SIGNAL

FIG. 3—SEMAPHORE MECHANISM

motor control sector and its contact fingers to the motor. The slot magnet being energized, the pawl is held in the path of the driving pins, and as the motor revolves one of the pins is forced against the pawl, thereby turning the slot-arm and the signal shaft to which it is connected. When the arm of the signal comes almost to its extreme position of proceed the motor current is broken by means of the controller, but this breaking of the current does not arrest the movement of the signal, on account of the inertia of the revolving armature and other parts. It is evident that, on account of the shunt field winding, the motor driven by its own inertia becomes a generator maintaining its field excitation. Immediately after the circuit between the motor and the battery is opened a low resistance circuit is closed between the motor brushes, thus converting the motor into a powerful electric brake to arrest the further movement of the signal. Any backward motion of the armature when the motor is stopped is prevented by the ball ratchet, so the signal is held in its clear position until the main circuit between the signal and the battery is opened.

The higher the voltage of the battery and the less the friction of the machine the greater will be the speed of the motor at the time the battery current is off, and the greater will be the inertia of the moving parts. The greater the speed of the motor the higher will be the E. M. F. generated in its armature and the greater will be the current opposing its forward movement when it is acting as a generator. Therefore, under all conditions, the motor will make approximately the same number of revolutions after its current is broken, stopping the signal arm at the same position. This arrangement eliminates the necessity of a friction brake, and at the same time secures much better results.

When the main signal circuit is opened and the slot-magnet de-energized, its heavy armature falls away from the poles, this movement being also assisted by the pressure of the driving pins against the pawl. The pawl being thrown back from engagement with the driving pin, the signal is free to assume the position to which it is normally carried by gravity. As the signal arm comes to its stop position, the rotation of the slot-arm causes its armature to swing back against the poles of the magnet so that it is in position to be held firmly in place when current is again applied.

This signal is specially designed for two-position work, yet it can be operated as a three-position signal when an extra circuit controller is used and a back contact provided on the line relay. Under these conditions, when indicating a back-up train movement, the signal will go from proceed to stop before assuming the caution position. There are many instances in three-position signaling in which such movement is not objectionable, and to such cases this signal is applicable.

Another feature in the design is that all parts are readily accessible and easily removed from the case when repairs or renewals are desired. Provision is also made for the proper lubrication of all parts. The motor and other parts are reversible to provide for upper and lower quadrant indications as desired.

Drainage of Roadbeds

Editor Railway Engineering:

Your article on "Causes of Roadway Deterioration" treats on the subject of drainage of roadbeds in which I am very much interested. I have therefore a few remarks to make, which may interest you and your readers.

My opinion is that an ideal roadbed is one which has a good foundation of crushed stone, gravel or hard material upon which is laid about a foot or more of crushed stone ballast and, in addition, is thoroughly drained by use of open ditches or tile as is necessary.

The depth of the foundation depends upon the condition of the ground. If it is a soft clay or quicksand the foundation should be several feet in depth. If lateral drains are used, I think they should be placed about two feet below the bottom surface of the ballast and should slope slightly. I believe it is good practice to use these

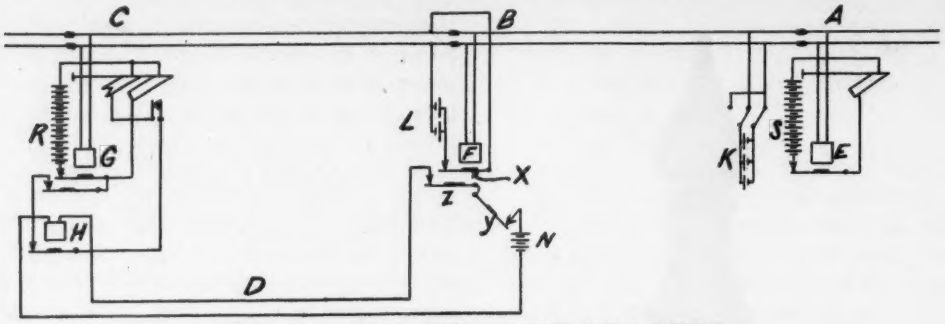


FIG. 2—TRACK CIRCUIT, AUTOMATIC BLOCK SIGNAL SYSTEMS

cross drains in deep cuts which have poor natural drainage. Everything should be done that will tend to keep the roadbed dry in those bad places. Drain tile should be laid about three or four below the lower surface of the ballast and about several feet from the end of the ties. The drain tile should have a fall of several inches to the hundred feet if it is possible to give that by varying its depth below the ballast. To keep the tile in position, I think it is necessary to use a wooden trough in which the tile is placed and covered with cinders. It would also be best to place the lateral tiles in troughs in order that they may be kept in working condition.

If a good roadbed is constructed at the start, there will be much less trouble in maintaining it as everyone knows. I hope that others will give their views through your columns, because every man meets different conditions in the work of track construction.

Yours truly, A. M. B.

Automatic Block Signal Systems

Chicago, Milwaukee & St. Paul Railway

SEVERAL typical track circuits of block signal systems, installed on the Chicago, Milwaukee and St. Paul road, are shown in the accompanying diagrams. Standard practice is represented in these track circuits.

The polarized system of distant signal control is shown

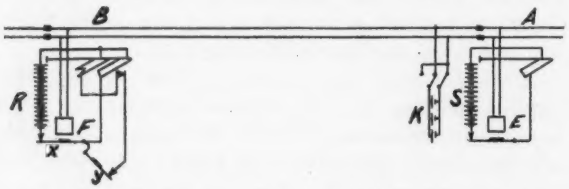


FIG. 1—TRACK CIRCUIT, AUTOMATIC BLOCK SIGNAL SYSTEMS

in Fig. 1. The wiring of last signal on the line is shown at A and of all other signals at B. The relay, F, has two armatures, x and y. The armature, x, is operated by a change in the amount of current flowing through the relay coils and is used for the control of the home signal. The armature, y, shifts the contact for the distant signal circuit, when the polarity of the relay is changed by a reversal of the direction of current in the track circuit. The reversal of current is caused by the advance home signal mechanism. When the home signal operates, the pole changer shifts the terminals of the battery, K. The distant signal is also controled through the contact of armature, x, at the home signal on the same post.

In Fig. 2 an arrangement is shown by which the track circuits are shortened. The operation of home signal at A reverses the polarity of the track circuit, B, and causes the armature, y, to open the line circuit, D, the distant signal being operated through the relay, H. When the train enters the track section, B, the armatures, x and y, open the track circuit, C, and line circuit, D, respectively and cause the home and distant signals at C to operate.

The distant signals may be controlled by line wires as in Fig. 3. The polarized armature is dispensed with in this system. The operation of the relay, E, on the track circuit, A, opens the home signal circuit at A. The line circuit, D, for the distant signal at C is opened by home signal circuit-breaker, T, at A. When the train is in track section, B, the relay, F, opens the track circuit, C, causing the operation of relay, G. Relay, G, opens the battery circuit of the signals at C.

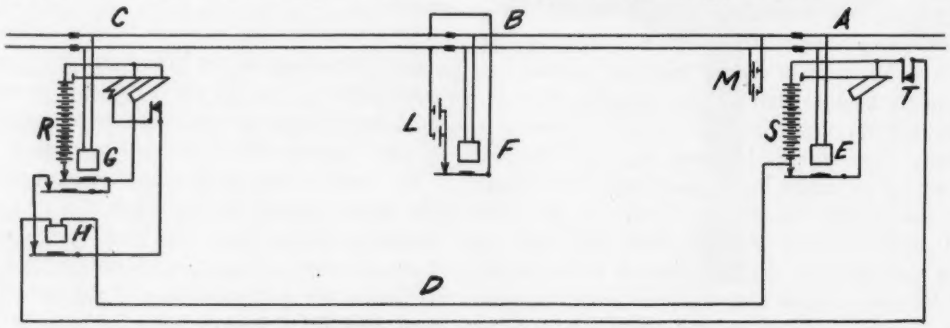


FIG. 3—TRACK CIRCUIT, AUTOMATIC BLOCK SIGNAL SYSTEMS.

Proportioning of Steel Railway Bridge Members*

By Henry S. Prichard, M. Am. Soc. C. E.

SEVERAL fundamental questions involved in proportioning steel railway bridge members are discussed in the article under the following captions: Available strength of structural steel; safe working stresses; rules for designing compression members; provisions for possible increase in live loads, and provision for the dynamic effect of the live load.

AVAILABLE STRENGTH OF STRUCTURAL STEEL

The conclusions, regarding the strength of structural steel, are based upon experimental data. These conclusions are summed up as follows: First, the available strength in either tension or compression is about 55 per cent of the ultimate tensile strength; second, under continuously alternating stresses of equal intensity, the available strength lies within the limits 35-45 per cent of the ultimate tensile strength, and, third, when long intervals of rest occur the strength is not impaired by occasional alternating stresses.

SAFE WORKING STRESSES

The recommendations for safe working are summed up as follows:

Safe working stresses for tension in main members, 16,000 pounds per square inch.

Safe loads on compression members, 15,000 pounds per square inch properly reduced for length.

Members liable to alternate stresses should be proportioned for each kind of stress separately considered, but each kind of stress should be regarded as increased by F per cent of the lesser kind, not including any increase on account of alternate stress from wind. When a member has riveted end connections, F should be 50; when it has pin ends, it should be 100.

Centrifugal force should be considered the same as life load and a corresponding addition should be made for dynamic effect.

RULES FOR DESIGNING COMPRESSION MEMBERS

During the last twelve years much attention has been devoted to the analysis of structural members in compression both under ideal conditions and the conditions of practice and many articles of great theoretical excellence have been published, notwithstanding which engineers are yet using formulas founded partly on the results of experiments and partly on false theories. In fact engineers in their practice, with regard to compression members, have profited very little from the increase in theoretical knowledge. This failure to obtain practical benefit from theory has been due partly to the fact that the theoretical column formulas are complicated and difficult to apply, partly to the fact that slight variations in the assumed conditions of practice make great differences in the results given by the formulas, and partly to the fact that considerations of stiffness make it necessary to prohibit long columns and reduce the allowed load on columns of moderate length, regardless of theory.

A good formula for compression members should be simple in its application; it should admit on occasion of allowance for intentional eccentricity or for transverse loading, such as a member's own weight; it should give results agreeing closely with theory for short members and allow loads somewhat less than allowed by theory for members of moderate length; it should provide an ample margin of safety as compared with the results of tests; and, to avoid flimsiness, it should gradually reduce the allowed unit load as the length increases, until it becomes zero at the limiting length. In regard to this last condition most of the formulas in use are quite faulty. What good reason is there for prohibiting the use of a column with an area of twenty square inches and a ratio of length to radius of gyration of 101, and allowing a column with an area of ten square inches and a ratio of 100 to be used to support a load of 86,000 pounds? This inconsistency is not unusual in bridge specifications.

Compression members take their names from their principal stress, but they are always liable to some bending stresses.

Bending stresses in compression members arise from three primary causes and one incidental cause. The primary causes are:

First—Prearranged or intentional eccentricity in the application of the longitudinal load; that is eccentricity that exists by reason of the design of the member and its connections.

Second—Transverse loading, such for instance, as a member's own weight.

Third—Defects in material, fabrication and erection; such as variation in elasticity and sectional area, which may shift the axis from the position assumed, and faulty alignment of the member. These defects exist to some extent in all compression members and by inducing deformation are highly detrimental, except for very short members.

The incidental cause is:

Deformation—This cause of bending stresses is unimportant for very short compression members, but its importance increases with the length of the member and is so great for long members that they will fail from this cause under loads which will produce only very small stresses from direct compression and primary bending moment.

Let B=area required for the primary bending moment.
D=area required for the incidental bending moment.
Z=variable factor, depending on the form of the moment diagram. If the cause of the primary bending moment is eccentricity, the value of Z may be taken as 1.234.
W=load producing the direct compression.
A=total area required for the cross-section of the member.
E=modulus of elasticity.
l=length of member in inches.
r=radius of gyration in inches.

*Extracts from paper in July proceedings of the Engineers' Society of Western Pennsylvania.

$$p = \frac{W}{A} \text{ and } q = \frac{^2E}{\left(\frac{1}{r}\right)^2}$$

$$D = B\frac{gp}{q-gp}Z$$

The area is not proportioned to the load, but it grows larger in proportion to the load as the load increases. It is therefore necessary to introduce a factor of safety, g, as regards the area required for the incidental moment. A good value for g is 3 in proportioning for the incidental bending moment.

Let p=the working load in pounds per square inch.

b=the compression per square inch from the intentional primary bending moment.

$$p = 15000 - b - \tfrac{2}{3}\left(\frac{1}{r}\right)^2$$

In determining the safe strength of a compression member in an existing structure, the value of p can be increased by a factor, K, say 25 per cent, and if the ends are evidently well fixed, the fraction 2/3 can be reduced to ⅜ on the assumption that the member is as stiff as it would be if it were only ¾ as long and had frictionless hinged ends.

PROVISION FOR POSSIBLE INCREASE IN LIVE LOADS

The method of proportioning bridges not only for the specified live load with the specified unit stresses, but also for a 50 per cent increase in the live load with maximum safe unit stresses (say 25 per cent greater than those specified) and for a 100 per cent increase in the load, with unit stresses 100 per cent greater than those specified, is objectionable in practice for the reason that it necessitates the use of three sets of unit stresses and leaves it a matter of trial to determine which condition of loading is the governing one in proportioning each bridge member. Precisely the same result can be accomplished, using only the specified unit stresses, by making proper additions to the stresses to provide for possible increase in live load. The amounts to be added can be determined as follows:

Let D=the dead load stress.

L=the static stress from the specific live load.

I=the addition for dynamic effect of the specified live load; or briefly, impact.

P=the amount to be added to the live load stresses and impact to provide for possible increase in loading.

When live and dead load stresses are of the same kind—

$$\frac{L+I+D+P}{16{,}000} = \frac{1\frac{1}{2}L+1\frac{1}{2}I+D}{20{,}000}$$

$$P = \frac{L+I-D}{5}$$

When the live and dead load stresses are of opposite kinds—

$$\frac{L+I-D+P}{16{,}000} = \frac{1\frac{1}{2}L+1\frac{1}{2}I-D}{20{,}000} \text{ or } \frac{2L+2I-D}{32{,}000},$$

whichever gives the largest result

$$P = \frac{L+I+D}{5} \text{ or } \frac{D}{2}$$ whichever gives the largest result

Whatever may be the necessity for provision for increase in loading under present conditions, there is little doubt that had it been made twenty or twenty-five years ago, it would have prolonged the life of many a bridge.

The provision for possible increase in loading, is made chiefly in the stringers, floor beams and light truss members, and even if the increase in loading does not occur the provision may not be amiss, as an increase in the speed of trains may increase the impact in the members in question, and a little extra metal in the floor system may compensate for deterioration from rust.

PROVISION FOR THE DYNAMIC EFFECT OF THE LIVE LOAD

The rapid application of the load, the hammering of the counter-weighted driving wheels and the jolting and teetering of the engines and cars produce an effect on bridges from impact and accumulative vibration, the determination of which, even if all the governing conditions were known, is such a complicated problem that it is hopeless to attempt a theoretical solution, but some phases of the problem have been successfully analyzed and the conclusions to which the analyses lead are of assistance in considering the general subject:

The conclusions to which this analysis of the dynamic effect of the live load has led can be formulated as follows:

Let L=the static stress, moment or sheer from live load.

S=the length in feet of the loaded portion of the span.

N=the number of loaded tracks causing the maximum stress, moment or sheer.

U=the percentage of increase from dynamic effect.

I=the addition for dynamic effect of the live load: or briefly, impact.

$I = UL$.

The provision for the dynamic effect of the live load should be made by adding percentages as follows:

For a loaded length of span less than 125 ft.,

$$U = (100 - 0.4S) - 10(N-1)$$

For a loaded length of span from 125 ft. to 500 ft.

$$U = 50 - 10\ (N-I)$$

For a loaded length of span over 500 ft.

$$U = (100 - 0.1S) - 10\ (N-I)$$

The percentages for various loaded lengths are given in the accompanying table.

The greatest speed observed during the tests on which the foregoing rules are based was about 70 miles per hour. Greater speeds occasionally occur on some roads, and may become frequent on many roads, and such greater speeds carry with them the liability to greater impact on short spans. Inasmuch, however, as the provision for possible increase in live load, plus the provision for impact herein recommended, makes a greater addition to the static stresses in the floor system and light web members, than is customary, and inasmuch as greater speed and greater load may not both occur, it was not deemed advisable to make a general recommendation for a further increase over current practice. In special cases, however, it may be advisable to increase the provision for impact on short spans.

The dynamic effect of the live load at train speeds less than 20 miles per hour was found to be very small in the

Robinson, Turneaure and Baltimore & Ohio Experiments, which confirms the wisdom of the usual practice of running slowly over bridges known or believed to be unsafe. Orders for slow speed, apart from the inconvenience they cause, are not a satisfactory remedy for weak or overloaded bridges, as there is some danger that the orders will not always be heeded, but they are a precaution which, with care, may prolong the life of an old bridge.

PERCENTAGES OF INCREASE FROM THE DYNAMIC EFFECT OF THE LIVE LOAD

S Loaded Length of Span	Percentage of Increase No. of Loaded Tracks 1	2	3	4
0	100	90	80	70
5	98	88	78	68
10	96	86	76	66
15	94	84	74	64
20	92	82	72	62
25	90	80	70	60
30	88	78	68	58
35	86	76	66	56
40	84	74	64	54
45	82	72	62	52
50	80	70	60	50
55	78	68	58	48
60	76	66	56	46
65	74	64	54	44
70	72	62	52	42
75	70	60	50	40
80	68	58	48	38
85	66	56	46	36
90	64	54	44	34
95	62	52	42	32
100	60	50	40	30
105	58	48	38	28
110	56	46	36	26
115	54	44	34	24
120	52	42	32	22
125 to 500	50	40	30	20
520	48	38	28	18
540	46	36	26	16
560	44	34	24	14
580	42	32	22	12
600	40	30	20	10
620	38	28	18	8
640	36	26	16	6
660	34	24	14	4
680	32	22	12	2
700	30	20	10	0
720	28	18	8	0
740	26	16	6	0
760	24	14	4	0
780	22	12	2	0
800	20	10	0	0
820	18	8	0	0
840	16	6	0	0
860	14	4	0	0
880	12	2	0	0
900	10	0	0	0
920	8	0	0	0
940	6	0	0	0
960	4	0	0	0
980	2	0	0	0
1000	0	0	0	0

Rail Specifications

THIS progress report of the Special Committee on Rail Sections of the American Society of Civil Engineers will be acted upon at the next annual meeting of the society. The report is as follows:

Your committee respectfully report that they have given the report which they submitted under date of January 17, 1906, and which was referred back to them, careful consideration, and would now report that they are in consultation with committees representing other societies and organizations, as well as other interested parties, on the subject of modified rail sections, with the purpose of preparing and submitting to your society a new series of such sections.

In this designing of heavier sections, particular attention is being given to the advisability of increasing the percentage of metal in the webs and flanges, as compared with the existing sections recommended by your society. This they hope to accomplish in due time, and in the meantime respectfully submit to the society for its consideration the following specification for the manufacture of Bessemer and open hearth rails:

BESSEMER STEEL RAILS.

Process of Manufacture.—The entire process of manufacture and testing shall be in accordance with the best state of the art, and the following instructions shall be faithfully executed:

Ingots shall be kept in a vertical position in the pit heating furnaces until ready to be rolled, or until the metal in the interior has had time solidify.

No bled ingots shall be used.

There shall be sheared from the ends of the blooms formed from the top of the ingots not less than 25 per cent, and if, from any cause, the steel does not then appear to be solid, the shearing shall continue until it does. If, by the use of any improvements in the process of making ingots, the defect known as piping shall be prevented, the above shearing requirements may be modified.

The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass the temperature of the rail will not exceed that which requires a shrinkage allowance at the hot saws, for a 33-ft. rail of 100-lb. section, of 6 7-16 in., and 1-16 in. less for each 5 lb. decrease of section. These allowances to be decreased at the rate of 1-90 in. for each second of time elapsed between the rail leaving the finishing rolls and being sawn. No artificial means of cooling the steel shall be used after the rails leave the rolls, nor shall they be held before sawing for the purpose of reducing their temperature.

Chemical Composition.—Rails of the various weights per yard specified below shall conform to the following limits in chemical composition:

	70 to 79 lb. Percentage.	80 to 89 lb. Percentage.	90 to 100 lb. Percentage.
Carbon	0.50 to 0.60	0.53 to 0.63	0.55 to 0.65
Phosphorus shall not exceed	0.085	0.085	0.085

Silicon shall not exceed	0.20	0.20	0.20
Sulphur shall not exceed	0.075	0.075	0.075
Manganese	0.75 to 1.00	0.80 to 1.05	0.80 to 1.05

Drop Test.—One drop test shall be made on a piece of rail, not less than 4 ft. and not more than 6 ft. long, selected from each blow of steel. The test piece shall be taken from the top of the ingot. The rails shall be placed head upward on the supports, and the various sections shall be subjected to the following impact tests under a free falling weight:

70 to 79 lb. rail.....18 ft.
80 to 89 lb. rails.....20 ft.
90 to 100 lb. rails.....22 ft.

If any rail breaks, when subjected to the drop test, two additional tests may be made of other rails from the same blow of steel, also taken from the top of the ingots, and if either of these latter rails fail, all the rails of the blow which the represent will be rejected, but if both of these additional test pieces meet the requirements, all the rails of the blow which they represent will be accepted.

The drop testing machine shall have a tap of 2000 lb. weight, the striking face of which shall have a radius of not more than 5 in. and the test rail shall be placed head upward on solid supports 3 ft. apart. The anvil block shall weigh at least 20,000 lb., and the supports shall be part of, or firmly secured to, the anvil. The report of the drop test shall state the atmospheric temperature at the time the test was made.

Section.—The section of rail shall conform, as accurately as possible, to the templet furnished by the railroad company, consistent with the paragraph relative to specified weight. A variation in height of 1.64 in. less, or 1-32 in. greater than the specified height, and 1-16 in. in width, will be permitted. The section of rail shall conform to the finishing dimensions.

Weight.—The weight of the rails will be maintained as nearly as possible, after complying with the preceding paragraph, to that specified in contract. A variation of one-half of 1 per cent for an entire order will be allowed. Rails will be accepted and paid for according to actual weights.

Length.—The standard length of rails shall be 33 ft. Ten per cent of the entire order will be accepted in shorter lengths varying by even feet to 27 ft., and all No. 1 rails less than 33 ft. long shall be painted green on the ends. A variation of ¼ in. in length from that specified will be allowed.

Drilling.—Circular holes for splice bars shall be drilled in accordance with the specifications of the purchaser. The holes shall conform accurately to the drawing and dimensions furnished, in every respect, and must be free from burrs.

Straightening.—Care must be taken in hot straightening the rails, and it must result in their being left in such condition that they shall not vary throughout their entire length more than 5 in. from a straight line in any direction, when delivered to the cold straightening presses. Those which vary beyond that amount, or have short kinks, shall be classed as second quality rails and be so stamped.

Rails shall be straight in line and surface when finished—the straightening being done while cold—smooth on head, sawed square at ends, variation to be not more than 1-32 in., and prior to shipment shall have the burn occasioned by the saw cutting removed and the ends made clean. No. 1 rails shall be free from injurious defects and flaws of all kinds.

No. 2 rails shall be accepted up to 5 per cent of the whole order. They shall not have flaws in their heads of more than ¼ in., or in the flange of more than ½ in. in depth, and, in the judgment of the inspector, these shall not be so numerous or of such a character as to render them unfit for recognized second quality rail uses. The ends of No. 2 rails shall be painted white, and shall have two prick punch marks on the side of the web near the heat number brand, and placed so as not to be covered by the splice bars. Rails from heats which failed under the drop test shall not be accepted as No. 2 rails.

Branding.—The name of the maker, the weight of the rail, and the month and year of manufacture, shall be rolled in raised letter on the side of the web; and the number of the blow shall be plainly stamped on each rail where it will not subsequently be covered by the splice bars.

Inspection.—The inspector representing the purchaser shall have free entry to the works of the manufacturer at all times when the contract is being filled, and shall have all reasonable facilities afforded him by the manufacturer to satisfy him that the finished material is furnished in accordance with the terms of these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment.

The manufacturer shall furnish the inspector, daily, with carbon determinations for each blow, and a complete chemical analysis every 24 hours, representing the average of the other elements contained in the steel, for each day and night turn. These analyses shall be made on drillings taken from small test ingots. On the request of the inspector, the manufacturer shall furnish drillings for check analyses.

BASIC OPEN HEARTH STEEL RAILS.

The specifications for rails made by the basic open hearth process shall be the same as for Bessemer rails, excepting that a full chemical determination shall be furnished for each heat and two drop tests from each. Their chemical composition shall be:

	70 to 79 lb. Percentage.	80 to 89 lb. Percentage.	90 to 100 lb. Percentage.
Carbon	0.53 to 0.63	0.53 to 0.68	0.65 to 0.75
Phosphorus shall not exceed	0.05	0.05	0.05
Silicon shall not exceed	0.20	0.20	0.20

Sulphur shall not exceed	0.06	0.06	0.06
Manganese	0.75 to 1.00	0.80 to 1.05	0.80 to 1.05

The insistence of the railroad engineers on high carbons is exemplified in the above chemical requirements for open hearth rails. At present the Tennessee Coal, Iron & Railroad Company, which was first to roll open hearth rails on any considerable scale, is furnishing 0.50 to 0.60 carbon in rails of 70 to 80 lb., 0.55 to 0.65 carbon in 80 to 90 lb. rails and 0.58 to 0.68 carbon in 90 to 100 lb. rails. The Tennessee Company's phosphorus maximum is 0.06, and its manganese range differs from the above in having the maximum 1.05 per cent for 70 to 80 lb. rails to 1.10 per cent for heavier rails.

Washington Terminal Improvements

TO SIMPLIFY and minimize the number of construction problems, which, of necessity, would have to be met on a work of this magnitude, the entire layout was divided into three separate parts or divisions: The terminal depot building, the north approach and the south approach. To avoid confusion and controversy with the operating departments of the Baltimore & Ohio and Pennsylvania railroads, upon whose respective territories much of the work had to be done, the construction of the north approach and the depot building was assigned to the Baltimore & Ohio R. R., while the south approach and a portion of the Magruder Connection was assigned to the Pennsylvania R. R.

The north approach embraces the train yard of 33 tracks, power plant, express building, coach yard having a capacity of about 750 cars, engine and repair yards with the necessary engine house and shop facilities, together with the Metropolitan and Washington Branch connections for the Baltimore & Ohio R. R. and a portion of the Magruder Connection of the P. B. & W. R. R.

The south approach embraces the girder-covered work under the plaza, the tunnel under Capitol Hill and the connection with the P. B. & W. R. R. on Virginia Avenue.

THE TERMINAL.

The head house is 620 feet long and 220 feet deep. The concourse is 760 feet long and 130 feet wide, exceeding in length by about 9 feet the length of the Capitol. The height of the head house is from 65 to 120 feet and it is being built of white granite from Bethel, Vermont. The three central arches, 30 feet wide by 50 feet high, greatly exceed in size their Roman prototypes. At the east pavilion is a 40-foot arch carriage entrance, leading to a suite of rooms for use of the President and guests of the Nation. The west 40-foot arch carriage entrance leads to the general carriage porch, near the ticket and baggage lobby. The end pavilions and the central vestibule are connected by an open-air portico, which together form a continuous covered porch the entire length of the building.

The general waiting room is 130 feet wide and 220 feet long, covered by a Roman barrel vault, 90 feet high, decorated with sunken panels after the manner of the baths of Diocletian. A semi-circular window 75 feet in diameter at each end and 5 semi-circular windows 30 feet in diameter on the sides, serve to light it. The dining room, lunch room and women's waiting room are grouped at the east end of this hall; while the ticket office, baggage checking room, smoking and package rooms are grouped at the west end. Telegraph and telephone booths will be located in the general waiting room. Office space is provided on the second and third floors.

The main floor level will be about 35 feet above the average ground level in the vicinity. This, of course, implied some radical changes in the street elevations to provide ingress, to and from the station. This was effected in part by establishing in front of the station, a grand plaza 940 feet long, by feet wide, decorated with fountains, balustrades and terraces. From this space will lead nine separate and distinct streets and avenues, four of which are new, others with directions changed to better suit the scheme, the remainder unchanged except that the grades of all are changed to meet the new level. Owing to this change in elevation, many of the street changes will extend quite a distance from the plaza, particularly those streets leading to the west and south, while the changes eastward will be short owing to rising ground.

To create this plaza and fill the streets leading to it, requires about three-quarters of a million yards of material, while a similar quantity can be utilized in bringing to the level of the new streets, the low property adjacent. This generous supply of streets will provide ample facilities for the prompt handling of the traveling public, to and from the trains, and the spacious plaza will serve for massing spectators and troops who attend such public ceremonies as take place at the Nation's Capitol.

NORTHERN APPROACH.

The width of the terminal train yard is 760 feet or equal to the length of the concourse, one-half of which is located on either side of the center line of Delaware avenue. The tracks in this space will be divided into two groups or sections. One section of 480 feet will contain the stub or main floor level tracks; the other 280 feet will contain the through or low level tracks leading to the tunnel, the difference in elevation at the north line of the concourse being 20 feet. The main floor tracks descend northward from the Station to a point near K street on a grade of .55%; the low level tracks ascend to K street at the rate of .8% to a common level, from which point all tracks ascend at a .95% to Florida avenue. From this point north and eastward the rates of grade are as follows: The Washington branch connection of the Baltimore & Ohio R. R. Co. and the P. B. & W. connection of the Pennsylvania R. R. Co. continue at an ascending grade of .95%, the Metropolitan Branch at .7% and the Coach Yard at .5%.

Certain platforms in the high group are set aside for the exclusive handling of baggage, to avoid congestion of passengers and baggage trucks. Similar arrangements were planned for the low section, but to provide

more tracks the baggage platform feature was eliminated and baggage and passengers will both be handled on the same platform. The same method will be employed on those platforms on the high level, where no baggage platforms are provided. As some trains carry more baggage than others, as effort will be made to handle trains with heavy baggage, on tracks adjacent to the baggage platforms.

The terminal limits, between the concourse line and L street, are defined by retaining walls ranging from 5 to 35 feet in height, above the present ground. The high and low groups of tracks are also separated by a retaining wall, extending from the concourse to a point near I street, where the grades of the two groups of tracks very nearly coincide. The west retaining wall betwen the station building and the power house was constructed in such a manner, as to contain a tunnel 12 feet wide and 13 feet high, in which will be carried the heat, air, water and pressure pipes and the electric light and power wires. This tunnel was carried under H. Street and a branch tunnel 5 feet wide and 7 feet high was constructed along the north abutment of H street to carry the necessary pipes and wires to the Express building on the east side. In the top of the arch were placed I-beams, spaced 10-foot centers, the lower flange projecting about 6 inches below the soffit. Hangers from these I-beams will support the pipes which pass through the tunnel, while the electric wires will be c arried in conduits supported along the sides. The east retaining wall between H and I streets was designed to carry the girder work supporting the roadway on the east side of the express house at the track level, and also to act as a retaining wall for Second street between H and I streets which rises at the rate of about 4% to I street, the track level entrance to the express building. The sections of this wall, therefore, change as the conditions require.

All the other walls are of the ordinary design of retaining wall, except possibly a little heavier than the ordinary construction, due partly to the fact of unsuitable foundations and because of the use of sand stone facing and concrete backing, which makes a somewhat lighter wall than other kinds of building material. All retaining walls and abutments north of the depot are constructed in accordance with the Baltimore & Ohio R. R. specifications for second class masonry, all exposed faces being sandstone backed with portland cement, concrete. The stone facing is carried from 12 to 18 inches below the finished surface; all masonry below this line is of portland concrete.

Granolithic platforms will be built between the tracks in the train yard, although it is probable that this work will not be done until after the filled material has had ample time to settle. It is not proposed to build at this point in a regulation train shed, but instead to have over each platform an umbrella shelter. There will be 19 of these sheds, each about 700 feet in length, although the platforms will extend about 200 feet further and will be about 900 feet in length.

SOUTHERN APPROACH.

The southern connection is by tunnel, open cut and viaduct. Starting at the south line of the head house, about 525 lineal feet of girder covered way is constructed ranging in width from 115 feet at the north end to 36 feet at the south where it joins the twin tunnel. From his point southwardly, a distance of about 4000 feet, the construction consists of two tunnels built side by side, each tunnel being 16 feet wide and 17 feet high from top of rail to soffit of arch. The division wall between these two tunnels is constructed of coursed stone masonry 4 feet in thickness, and contains openings at intervals of 100 feet providing access between the tunnels and refuge niches for the protection of track men. The side walls and haunches are being constructed of concrete and the arches of five rings of brick. The conduits for the accommodation of the electric wires are being laid in the haunching as it is being constructed, access to which will be had by man-holes located above the spring line, at intervals of 400 feet. To prevent these tunnels from dampness, as far as possible, gutters are being constructed on each side some distance from the spring line of the arch, from which down spouts will lead to the sub-grade at intervals of about 50 feet. In constructing the side walls for this work, forms constructed of steel plates ¼ inch thick, 4 feet wide and 10½ feet high, stiffened with angle iron flanges on all edges and three horizontal angles dividing the height into four equal spaces, are used. These forms are held in place by timbers which extend across the width of the cut. The centres used in the construction of the arches are made of T shaped steel ribs, formed by riveting together two angles 4 x ½ inches, made in two sections joined at the crown by fishplates, and are held together by tie rods attached to angle flanges. The top and a portion of the sides will be waterproofed, with four layers of waterproofing felt laid in waterproofing compound. Upon this will be placed one inch of cement mortar for the open work and a layer of brick for the drift portion of this work. Of the tunnel constructed to date, practically all has been done by the cut and cover method.

Uniform and satisfactory progress was made in the construction of the south approach, a large percentage of which is tunnel and girder covered work. There are 525 feet of girder covered work which was built in open cut. Of the tunnel work, 2480 feet is drifted; the balance, 600 feet at the north end and 950 feet at the south end, was constructed in open cut. As no shafts were allowed the drift tunnelling was done from the south end. At this point all excavation was loaded on standard gauge cars to be removed by the railroad. Here was located the plant for mixing concrete and handling the other materials entering into the permanent construction. This plant, including the motive power for conveying the concrete to the work, was operated by electricity. The shovel used in excavating the mass of the material removed in building and tunnel was operated by compressed air. By the use of these appliances all smoke

and gases were avoided, allowing the workmen to perform their labors under the most favorable conditions without adding materially to the cost of construction. The remainder of this work consists of cut and embankment with bridges over intersecting streets.

There are several points worthy of special note in connection with this construction: First, the construction of two tunnels, side by side, separated by a dividing wall but 4 feet in thickness. The work on one tunnel, embracing a side wall and the middle wall with connecting arch, was carried on somewhat in advance of the other, after the custom in building single tunnels; the construction of the other side wall with its connecting arch then followed, completing the two-track tunnel. Second, the enormous amount of timber used in supporting the overlying material during the construction of the masonry.

The crown bar system of timbering was first employed in the removal of the earth from the space in which the arch was to be built. Segmental timbers were then placed inside the crown bars to strengthen the work. The timber is about 2 feet in thickness.

MARYLAND AND VIRGINIA AVENUES IMPROVEMENTS.

Starting at the Potomac river, the main line of the Pennsylvania R. R. occupies a walled cut in Maryland avenue and all streets are carried over. Near the intersection of Maryland and Virgina avenues, the tracks pass from a walled cut to an elevated structure which extends as far east as S. Capitol street and Virginia avenues. Over this portion of the line the streets are taken under the tracks. The roadbed for tracks on both these avenues is protected by retaining walls. Some street grade changes were necessary. From S. Capitol street and Virgina avenue to Second street and Virginia avenue, through Garfield Park the construction consists of a walled cut on the line of Virginia avenue, thence by double track tunnel to a connection with the present tracks near Virginia avenue and Ninth street.

B. & O. COAL YARD.

The space upon which the north approach to the Terminal is constructed, was covered with dwellings, warehouses, coal yards, freight yards and sheds, and the main tracks and sidings of the Washington and Metropolitan Branches of the Baltimore & Ohio R. R. Co. As previously stated the west end of the Station building is constructed on ground formerly occupied as a coal yard by the Baltimore & Ohio R. R. Co. As it was necessary to clear the ground for the Terminal construction, this Company was obliged to construct a new coal yard on square 711, bounded by M, 1st, N and 2d streets, N. E.

On this block was constructed six lines of trestle about 19 feet in height and 600 feet in length, having a capacity of about 60,000 tons. The tracks are arranged in pairs, spaced 52 feet centre to centre, with a 7 foot division fence located halfway between. Each trestle has its macadam roadway 33 feet in width. The trestle bents, stringers, ties and braces are all of Georgia yellow pine, while the bins are short leaf Georgia. All bents rest on concrete foundations ranging in depth from 3 to 14 feet, depending on character of foundation encountered. The ground and trestles are the property of the Baltimore & Ohio R. R. Co. and are leased to six of the largest coal dealers, located on the Baltimore & Ohio Railroad in Washington.

B. & O. FREIGHT TERMINAL.

The Union Station Act precluded the construction of a freight yard near the passenger station. The Baltimore & Ohio R. R. was therefore obliged to locate its freight terminal at New York and Florida Avenues. As indicated on the plan, the inbound house 50x600 feet is located parallel with and 35 feet west of New York Avenue. The outbound house 22x300 feet is also parallel with New York Avenue, but 120 feet northwest of the inbound house. In the space between these two houses are located two 10 foot platforms, one adjacent to each house; two 10 foot transfer platforms 600 feet long, between the groups of tracks; and 7 tracks, two pairs and one group of three, one pair adjacent to each house while the group of three is located in the middle of the space.

Northwest of the freight house are located the team or bulk freight tracks, 14 in number and about 1,200 feet in length. Between the inbound and outbound houses is located a two-story office building, 25x121 feet. At the end of the outbound house are located two tracks about 800 feet long(which are set aside for handling meats, at the end of the inbound house are two tracks, over which there has just been erected a gantry crane which will be operated by electricity. It has two hoists, a high speed of 10 tons capacity and a low speed of 25 tons. The capacity of the bulk yard is about 450 cars; the house tracks have a capacity of about 200 cars; and the storage yard which is being constructed between the old and new Metropolitan Branch lines, will have a capacity of about 600 cars. The tracks in this yard are divided into three groups, for convenience in handling business and also for the purpose of utilizing the ground to the best advantage.

It will be noted that there is a great difference between the areas of the two houses. This is accounted for by the fact that the percentage of business handled in Washington, is 80% inbound and 20% outbound. Washington is not a manufacturing city, but on the contrary, industries of this character are discouraged to such an extent that practically no manufactories exist.

COACH YARD, ROUND-HOUSE AND SHOPS.

Extending from the throat of the train yard near K street to the site of the round-house and shops, there are two tracks, set inside for the handling of equipment. These tracks connect near New York and Florida avenues with the coach yard, and from the Terminal Station to this point, will be used for the handling of all kinds of equipment. From this point to the round-house and shops, they will be used principally for the handling of locomotives to and from the round-house.

The coach yard is located between the Washington and Metropolitan main lines and the "Y" connection between them. This yard is designed for the accommodation of the different classes of equipment, which will be handled over the different roads using this Terminal, one portion of the yard being set aside for the care of Pullman cars, adjacent to which will be located the building for the accommodation of the car cleaners, and the housing of supplies, etc. The spaces between certain tracks are provided with covered platforms, to be used in connection with the cleaning of these cars.

From the space, which this yard occupies, was obtainable a large part of the material required to fill the space between the walls of the Terminal, around the foundations of the depot and the plaza with its street approaches. The average depth of cut over a large portion of this space reaches 50 feet, the maximum cut being 82 feet. The entire cut contains about 2,000,000 cubic yards of material consisting of clay and clay and sand mixed, of a character easily handled by steam shovels. Six 70-ton steam shovels have been engaged on this work, three of which are of the Bucyrus and three of the Vulcan type, each having a capacity of about 30,000 cubic yards per month. The excavated material was hauled on narrow gauge dump cars of 4 yards capacity in trains of 10 to 12 cars each, the average haul being about 1½ miles.

Northeast of the "Y" connection is located the roundhouse and shops and engine storage yard, the tracks leading to the same passing under the "Y" connection between the Washington and Metropolitan Branches of the Baltimore & Ohio R. R. Co. Considerable thought has been given to the arrangement of tracks in this yard to insure convenience and safety, as well as to prevent the fouling of important running tracks in operation.

The 25-stall engine houses are planned, each having its own turntable, each of which is accessible from both sides of the coal-wharf located a short distance west. The coal wharf consists of a series of bins provided with measuring devices, into which the coal is dropped direct from the drop-bottom cars. The approach to the bins is by the ordinary trestle incline. Two ash pits are provided with depressed ash tracks, so arranged that the tops of cars when standing on them, fall below the bottom of the pit, thus reducing the labor of handling the cinder.

The following contractors have been engaged on this work: Northern approach, grading and masonry, Mc Mullen & McDermott and Hoffman Engineering & Contracting Co.; steel work in bridges, Milliken Bros.; erection of steel work, Youngstown Construction Co.; Terminal Depot, foundation and granite work, Thompson-Starrett Co.; steel work, American Bridge Co.; power house and express building, exclusive of steel work, Jas. Stewart & Co.; steel work, American Bridge Co.; Southern approach, New York Continental Jewell Filtration Co.; improvements on Virginia and Maryland avenues and Magruder connection, Drake & Stratton Co.; Baltimore & Ohio freight and coal yards, grading, Stewart & Wilmoth; freight sheds and coal trestles, Edward Brady & Sons. All track laying will be done by the railroad companies.

Effect of Moisture on Wood

The effect of water in softening organic tissue, as in wetting a piece of paper or a sponge, is well known, and so is the stiffening effect of drying. The same law applies to wood. By different methods of seasoning two pieces of the same stick may be given very different degrees of strength.

Wood in its green state contains moisture in the pores of the cells, like honey in a comb, and also in the substance of the cell walls. As seasoning begins, the moisture in the pores is first evaporated. This lessens the weight of the wood, but does not affect its strength. It is not until the moisture in the substance of the cell walls is drawn upon that the strength of the wood begins to increase. Scientifically, this point is known as the "fiber-saturation point." From this condition to that of absolute dryness the gain in the strength of wood is somewhat remarkable. In the case of spruce the strength is multiplied four times; indeed, spruce, in small sizes, thoroughly dried in an oven, is as strong, weight for weight, as steel. Even after the reabsorption of moisture, when the wood is again exposed to the air the strength of the sticks is still from 50 to 150 per cent greater than when it was green. When, in drying, the fiber-saturation point is passed, the strength of wood increases as drying progresses, in accordance with a definite law, and this law can be used to calculate from the strength of a stick at one degree of moisture what its strength will be at any other degree.

Manufacturers, engineers, and builders need to know not only the strength but the weakness of the materials they use, and for this reason they are quite as much interested in knowing how timbers are affected by moisture as they are in knowing how they are weakened by knots, checks, cross-grain, and other defects. It is obvious that where timbers are certain to be weakened by excessive moisture they will have to be used in larger sizes, for safety. So far, engineers of timber tests, while showing that small pieces gained greatly in strength, do not advise counting on the same results in the seasoning of large timbers, owing to the fact that the large timbers usually found in the market have defects which are sure to counterbalance the gain from seasoning.

The Forest Service has just issued a publication entitled "The Strength of Wood as Influenced by Moisture," in which are shown the strength of representative woods in all the degrees of moisture from the green state to absolute dryness, and the effects of resoaking. This publication will be sent free upon application to the Forest Service, U. S. Department of Agriculture, Washington, D. C.

Prices on Track Materials, F. O. B. Chicago

TRACK SUPPLIES.

Steel Rail, 60 lbs. and over.....$28.00 per gross ton
Steel Rail, 30 to 45 lbs..... 34.00 per gross ton
Steel Rail, 25 lbs..... 35.00 per gross ton
Steel Rail, 20 lbs..... 36.00 per gross ton
Steel Rail, 16 lbs..... 37.00 per gross ton
Steel Rail, 12 lbs..... 38.00 per gross ton
Ties, 6x8x8 oak, 1st grade.....77c each
Ties, 6x8x8 oak, 2d grade.....67c each
Switch Ties .....$30.00 to $35.00 M. ft.

Angle bars, accompanying rail orders, 1907 delivery, 1.65c.; car lots, 1.75c. to 1.85c.; spikes, 2.10 to 2.20c., according to delivery; track bolts, 2.60c. to 2.70c., base, square nuts, and 2.75c. to 2.85c., base, hexagon nuts. The store prices on track supplies range from 0.15c. to 0.20c. above mill prices. Switch set per turn out, 60-lb. rail, $85 to $90.

OLD MATERIAL.

	Per Gr.	Per Ton
Old Steel Rails, rerolling.....	$16.75	to $17.25
Old Steel Rails, less than 3 ft.....	17.00	to 18.00
Old Iron Rails.....	20.25	to 20.75

SHEET STEEL.

It is quoted for future delivery:

Tank plate ¼-in. and heavier, wider than 6¼ and up to 100 in. wide, inclusive, car lots, Chicago, 1.88c., to 2.08c.; 3-16 in., 1.98c. to 2.18c.; Nos. 7 and 8 gauge, 2.03c. to 2.23c.; No. 9, 2.13c. to 2.33c. Flange quality, in widths up to 100 in., 1.98c. to 2.08c., base for ¼-in. and heavier, with the same advance for lighter weights; Sketch Plates, Tank quality, 1.98c. to 2.18c.; Flange quality, 2.08c. Store prices on Plates are as follows: Tank Plate, ¼-in. and heavier, up to 72 in. wide, 2.20c. to 2.30c.; from 72 to 96 in. wide, 2.30c. to 2.40c.; 3-16 in., up to 60 in., wide, 2.30c. to 2.40c.; 72 in. wide, 2.50c. to 2.65c.; No. 8 up to 60 in. wide, 2.35c. to 2.45c.; Flange and Head quality, 0.25c., extra.

STRUCTURAL STEEL SHAPES.

Store quotations are unchanged at 2.05c. to 2.10c., and mill prices are as follows: Beams and Channels, 3 to 15 in., inclusive, 1.88c.; Angles, 3 to 6 in., ¼-in. and heavier, 1.88c.; larger than 6 in. on one or both legs, 1.98c.; Beams, larger than 15 in. 1.98c.; Zees, 3 in. and over, 1.88c.; Tees, 3 in. and over, 1.93c., in addition to the usual extras for cutting to extra lengths, punching, coping, bending and other shop work.

CAST IRON PIPE.

Quotations per net ton on Water Pipe, 4 in., $38 to $39; 6 to 12 in., $37 to $38; over 16 in., $36 to $37; with $1 per ton extra for gas pipe.

CEMENT.

Good grade Portland Cement, car lots....$2.00 per bbl.*

* (Four sacks per bbl. credited 10c. each when returned in good condition.)

SAND.

Bank sand, car lot.....$0.65 per yd.
Torpedo sand, cart lot..... 1.15 per yd.

CRUSHED STONE GRAVEL.

Crushed limestone, car lot.....$1.05 per yd.
Crushed gravel, car lot ..... 1.00 per yd.

Personals

Mr. W. L. Mattoon has recently been transferred from the position of division engineer on the Zanesville and Western and Corning Division of the T. & O. C. Ry's. and has accepted the position of principal assistant engineer under the chief engineer of the Hocking Valley and Zanesville and Western Ry's.

Mr. D. C. Holtsbery, formerly division engineer of the eastern division of the T. & O. C. Ry., with headquarters at Bucyrus, Ohio, succeeds Mr. Mattoon as division engineer of the territory above mentioned and Mr. R. P. Black, formerly with the Pennsylvania lines west of Pittsburg, in charge of some construction work on the Indianapolis division, succeeds Mr. Holtsbery at Bucyrus.

Mr. Parker S. Cott, formerly principal assistant engineer on the H. V. & Z. and Western Ry's., resigned to accept a responsible position with the Sunday Creek Coal Co., at Athens, Ohio.

Mr. E. L. Trowbridge has been appointed assistant to the engineer of construction of the Louisville & Nashville at Louisville, Ky., in place of Mr. H. W. Oliver, resigned.

Mr. L. Slattery has been appointed signal engineer of the Chicago, Indiana & Southern, with headquarters at Gibson, Ind., in place of Mr. Byron Layton, resigned.

Professor William Freeman Myrick Goss, who has just accepted the position of Dean of the College of Engineering of the University of Illinois, is an engineer well and widely known both in the educational world as well as in the field of scientific and practical engineering. Professor Goss was born in Massachusetts in 1859 and received his certificate of graduation from the Massachusetts Institute of Technology in 1879. He received the degree of Master of Science from Wabash College in 1884 and the honorary degree of Doctor of Engineering was conferred upon him by the University of Illinois in 1904. In 1879, he was called to Purdue University to organize there the department of practical mechanics. Since 1890, he has been Dean of the Schools of Engineering and Director of the Engineering Laboratory at Purdue. As a result of his successful work at that institution he has become recognized as an authority on many aspects of the steam engine and has won for himself an international reputation in the field of railway engineering. He is a member of the leading engineering and technical societies of the United States and is the author of several engineering books and various monographs of a scientific nature Professor Goss is to take up his work at the University of Illinois this month and will be Dean of the College of Engineering and Director of the School of Railway Engineering. This school is a newly organized one and the University intends to develop in it a complete and compre-

hensive scheme of training for the railway service, including railway organization and operation as well as railway engineering. The four following professorships have thus far been established: That of railway civil engineering; railway mechanical engineering; railway electrical engineering, and railway administration. Professor Goss will direct and develop this school as a part of the college of Engineering and will do much towards making this college of the University of Illinois the finest technical school in the Uinted States.

Mr. A. L. Kleine has resigned as roadmaster of the Missouri, Kansas & Texas at Greenville, Tex.

Mr. V. E. Ohl has resigned as chief engineer of the Tennessee Coal Iron & Railroad Company to become city engineer of Ensley, Ala.

Mr. L. L. Sparrow has been appointed engineer of roadway of the first division of the Atlantic Coast Line, with office at Rocky Mount, N. C.

Mr. W. J. Bergen, chief supervisor of track of the New York, Chicago & St. Louis, has been appointed assistant to the chief engineer, with headquarters at Cleveland, O., performing such duties as may be assigned to him by the chief engineer. Mr. C. B. Hoyt has been appointed superintendent of track maintenance and construction, with office at Cleveland, succeeding Mr. Bergen. He will have charge of all matters relating to construction and maintenance of roadway, track and fencing.

Mr. C. G. Delo, engineer of maintenance of way of the Chicago & Alton at Kansas City, Mo., has been transferred to Bloomington, Ill., in a similar capacity, succeeding Mr. W. B. Causey, promoted.

Prof. Charles Henry Benjamin has been appointed dean of the school of engineering of Purdue University to succeed Prof. W. F. M. Goss, who recently resigned to accept a similar position at the University of Illinois. Professor Benjamin comes to Purdue from the chair of mechanical engineering at the Case School of Applied Science of Cleveland, O., which he has occupied for the past nine years. He is a graduate of the University of Maine and has had an unusually successful experience as a teacher and author on engineering subjects.

Mr. G. D. Fowle, signal engineer of the Pennsylvania Railroad, has been appointed consulting signal engineer. Mr. A. H. Rudd, assistant signal engineer, succeeds Mr. Fowle as singnal engineer, and Mr. C. C. Anthony, heretofore inspector of signals, has been appointed assistant signal engineer in place of Mr. Rudd.

Mr. J. T. Arundel, division superintendent of the Canadian Pacific at Winnipeg, Man., has been transferred to Vancouver, B. C., in a similar capacity, succeeding Mr. H. E. Beasley, transferred.

Mr. F. Kestler, heretofore assistant division superintendent of the Louisville & Nashville at Birmingham, Ala., has been appointed general superintendent of the Birmingham Southern, with headquarters at Birmingham.

Mr. A. J. Stone, heretofore assistant general manager of the Erie, has been appointed general superintendent, with office at Jersey City, N. J., to succeed Mr. R. H. Bowron, resigned, and the former position has been abolished.

Mr. S. B. Zartman, heretofore trainmaster of the Seaboard Air Line at Jacksonville, Fla., has been appointed superintendent of terminals at that point. Mr. E. R. Teague succeeds Mr. Zartman as trainmaster at Jacksonville.

Mr. W. B. Allen has been appointed trainmaster of the Chicago, Cincinnati & Louisville at Peru, Ind., succeeding Mr. G. S. Cooke, resigned. Mr. E. C. Murphy has been appointed superintendent of telegraph and chief train dispatcher, with office at Peru, Ind., succeeding Mr. Allen.

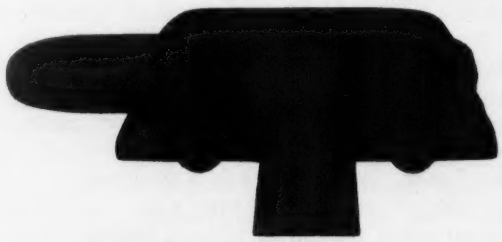
Miller Rail Anchor

The rail anchor, which is here illustrated, is manufactured by the Miller Anchor Company of Norwalk, Ohio. The anchor is of cast steel and weighs about 112 pounds.

The anchor has the advantage of being placed in position or detached from the rail easily and quickly and also the advantage of fitting any section. It can be placed at any point on the rail and is reversible. There are no rights and lefts, the pull may be in either direction at one setting.

MILLER RAIL ANCHOR, UNDER SIDE

The construction and application of the anchor is shown in the accompanying illustrations. One view is of the under side, showing the clamping cams spread to allow the anchor to be placed over the rail head. The other view shows the anchor in position on the rail with the cams rotated a quarter turn to lock the anchor.



MILLER RAIL ANCHOR IN POSITION

Automatic Safety Device for Facing Poin Switches

For many years one of the causes of wrecks on steam railroads has been open switches. A great many of this class of wrecks are not of a serious character, but all tend to show that where the man is depended upon to close and lock switches, he forgets and neglects to do so a great many times. On the other hand some

SWITCH OPEN, AUTOMATIC SAFETY DEVICE

of this class of wrecks are attended by terrible loss of life and destruction of equipment. In the last year there have been over fifty open-switch accidents; with 141 killed and hundreds injured.

On December 21, 1906, and January 23, 1907, a safety device designed to close an open switch in the face of an approaching train, running at any rate of speed and with the switch locked open, was tested on the L. S. & M. S. Ry. at Silver Creek, N. Y. Although the mechanism, which was the first built, was very crude, the switch was closed and locked with a trial engine running at a speed exceeding sixty miles per hour and the appliance was declared a success in every respect by a number of officials of the L. S. & M. S. Ry. and the Pennsylvania R. R. who were present. Since then the device has been improved greatly, and within a short time will be demonstrated in all of the railroad centers in the United States and Canada.

This device is the invention of Ernest F. Greene, and improvements have been made upon the same by Mr. Greene and Mr. Peter F. Kiefer, his machinist. Cuts, accompanying this article, will give a very clear idea of the working of this device. The appliance can be attached to any switch or switch-stand now in use, the connection rod being removed. In its place a telescopic connection rod, with a powerful compression spring and a latch, is installed. Attached to the latch by means of a connecting link, is a pipe line leading along the track to a trip lever at any required distance from the switch. The action of the appliance is so rapid and positive that it is practicable to place the trip within twenty feet of the switch, at which distance it is impossible to run a train fast enough to reach the switch before the same is closed and locked by the device. The connections are at all times perfectly rigid, except for the brief instant while the fly rails are travelling from the open position to the closed, under the impulse of the spring before referred to. When the switch is closed, the trip lever or trigger is below the level of the rails. Opening the switch for the side track pushes the pipe line and elevates the trigger to an upright position. If the switch is closed, the trigger is depressed to its inoperative position, so that the ordinary use of the switch is not interfered with in any manner, but it is impossible to open the switch without raising the trigger, which will remain so as long as the switch is open. Should the crew, using the switch, lock it open and leave it, the train approaching and entitled to the main line, without regard to the speed of the train, will engage the trigger, by means of a roller on the pilot, and release the latch by tension on the pipe line, alowing the spring to close the switch instantly and the latch to return and lock the switch in its closed position. After this has been done, the switch stand being locked open and the connection rod shortened, it cannot be opened for the siding without unlocking the stand, pulling out the latch and bringing the hand lever around to its normal position. This action puts the spring in compression, puts the target right and makes it possible to again use the switch as ordinarily, but under no circumstances is it possible to use the switch after being closed by this device without putting the whole safety device in working order.

The result aimed at is accomplished with the same force at any rate of speed, and the shock is not applied directly to the closing mechanism. The only part of the device subject to the shock is the trip lever and pipe line, which is comparatively light and very strong, and the shock is also absorbed by connection of the pipe line with the main spring. It has been fully demonstrated that the mechanism of this device will stand up under any rate of speed. The appliance is capable of thorough protection from the weather, and can be installed without delay to traffic on the busiest roads. It is very cheap to install, and is so simple mechanically that it appeals to the railroad man.

The device in its original crude form was demonstrated in Chicago on the Chicago Terminal Transfer tracks in March last, during the Maintenance of Way convention.

The Greene Railroad Safety Device Company, of Buffalo, N. Y., who are handling the appliance described, are in a position to demonstrate to maintenance-of-way officials that such accidents can positively be prevented by the installation of the Greene railroad safety device for facing point switches. It is claimed that it will last for years, without any attention other than the ordinary care given switches and that the device positively closes and locks the switch even though locked open at the stand, at any rate of speed, and without any attention whatever from anybody on the train or on the ground. It is said to be positively automatic, thoroughly mechanical, requiring no electrical connections of any kind and not interfering with any electrical protection already established.

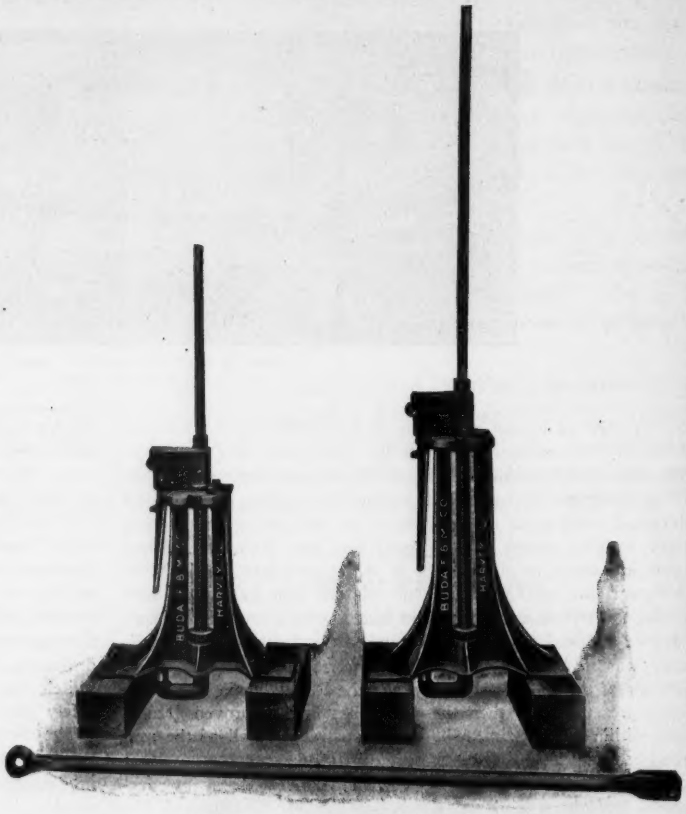
THE TRIGGER SWITCH CLOSED

THE TRIGGER, SWITCH OPEN

Malleable Iron Switch Stands

To the fifty or more styles which they now manufacture, The Buda Foundry & Manufacturing Co., of Chicago, have recently added the high and low forms of stand, illustrated herewith. These stands are built to meet the demand where lightness and strength are required. The frame, lever and the housing over it are of malleable iron. The housing protects the lever against snow and ice, and also makes a ready place for the switch lock. The mast and crank are of wrought steel. The illustration shows stand with crank of the turned-up toe style. Some prefer this as it is impossible to remove the switch rod when the stand is locked. The rod can only be taken off when the stand is in an intermediate position. When desired, other designs of cranks may be arranged for. These are shown in the smaller cut. When the turned-up or turned-down toe is used, the switch rod shown herewith is employed. If the stand is desired with horizontal rigid crank, or with the adjustable crank also shown, the connecting rod will have jaw at each end. By extending the crank below the base, the use of a straight rod is permitted and this is considered quite an advantage.

The stands are furnished either two-way or three-way. It should be mentioned that the frame has no bolts, thus any maliciously inclined persons are prevented from tampering with it.

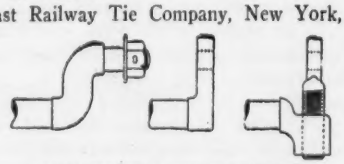


MALLEABLE IRON SWITCH STANDS

Trade Notes

Scullin-Gallagher Iron & Steel Company has removed its New York office from 111 Broadway to the fourteenth floor of the new building at 1 Wall street.

Pacific Coast Railway Tie Company, New York, N. Y., has



CRANK DESIGNS, SWITCH STANDS

been incorporated with a capital stock of $50,000 for the manufacture of railway ties, etc. The incorporators are: Robert J. Campbell, 5 West Eighth street, New York; William J. Wilsey, Portland, Ore., and Thomas H. Smith, 44 Jane street, New York.

Technical Publications

SUBSTITUTION OF THE ELECTRIC LOCOMOTIVE FOR THE STEAM LOCOMOTIVE (with discussions) by L. B. Stillwell and H. St. Clair Putnam. Published by the American Institute of Electrical Engineers, New York. Cloth binding, 132 pages, 6x9 ins., with illustrations diagrams and folders. Price $1.00.

The paper on the substitution of the electric motor for the steam locomotive by Stillwell and Putnam, presented at the 213th meeting of the American Institute of Electrical Engineers, and the subsequent discussion of the paper has been compiled and placed in book form. As the paper has been so widely discussed in the technical press, it will not be necessary to call attention to its importance. With the discussion, it comprises one of the most important works on heavy electric traction that has yet been published.

ELECTRIC RAILWAY ENGINEERING, by H. F. Parshall, M. Inst. C. E., and H. M. Hobart, M. I. E. E. Published by D. Van Nostrand Co., New York. Cloth Binding, 475 pages, 7x10½ ins., with 437 illustrations and a large number of folders. Price $10.00.

This is one of the most complete works on electric railway engineering ever issued and the standing of the authors in the engineering field gives a character to the work which can be accepted without question. The book deals with the broad subject of the electrification of railroads and contains the results of the author's observations and experience in that branch of engineering. The work is divided up into three parts as follows: First, the mechanics of electric traction; second, the generation and transmission of the electrical energy, and third, the rolling stock. The subjects discussed in the first part are tractive resistance at constant speed, acceleration, the tractive force, the power and energy at the axles, etc. In part two, the electric power generating plant is considered, also sub-stations, distributing systems, etc. Part third deals with electric locomotives, cars and rolling stock. As a practical discussion on this important subject, the book will be an invaluable aid to those who are engaged in the electrification of railroads.

A COURSE IN STRUCTURAL DRAFTING, by W. D. Browning, M. E. Published by the Industrial Magazine, Collinwood, Ohio. Cloth binding, 64 pages, 6x9 in., and 15 plates of standard drawings. Price, $1.00 postpaid.

The book describes and illustrates the standard practice in structural drawing. The object is to acquaint the draftsmen with drawings for the construction of iron and steel structures.

The Joseph Dixon Crucible Company has recently issued circular relating to the advantages of Fall painting. The facts, which are presented, favor the painting of bridges and other steel structures at this period of the year.